



Total Maximum Daily Load

for

**Pomme de Terre Lake
Hickory, Polk Counties**

303(d) Listing: Chlorophyll-a

**Submitted: July 22, 2025
Approved: August 5, 2025**

WATER BODY SUMMARY
Total Maximum Daily Load (TMDL) for Pomme de Terre Lake
303(d) Listing: Chlorophyll-a

Water Body:

Pomme de Terre Lake

Location:

Hickory County

Polk County

TMDL Development Priority:

High

8-digit Hydrologic Unit Code (HUC):¹

HUC 10290107 – Pomme de Terre

12-digit HUC Subwatersheds:

See Section 2

Water Body Identifications (WBIDs) and Hydrologic Class:²

7238 - Class L2

Designated Uses:³

Irrigation

Warm water habitat (aquatic life)

Human health protection

Whole body contact recreation category A

Secondary contact recreation

Livestock and wildlife protection

Impaired Use:

Warm water habitat (aquatic life)

Pollutant Identified on the 2022 303(d) List:

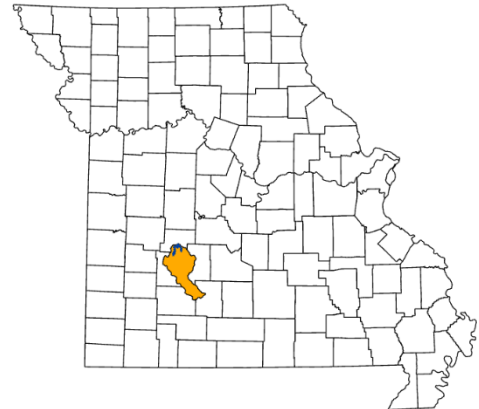
Chlorophyll-a (water)

Identified Sources on the 2022 303(d) List:

Nonpoint source

Size and Location of Impaired Segment:

WBID 7238, 7,675 surface acres, Section 2, Township 36N, Range 22W



Location of watershed in Missouri

¹ Watersheds are delineated by the U.S. Geological Survey using a nationwide system based on surface hydrologic features. This system divides the country into 2,270 8-digit hydrologic units (USGS 2019). A hydrologic unit is a drainage area delineated to nest in a multilevel, hierarchical drainage system. A hydrologic unit code is the numerical identifier of a specific hydrologic unit consisting of a 2-digit sequence for each specific level within the delineation hierarchy (FGDC 2003).

² For hydrologic classes see 10 CSR 20-7.031(1)(E). Class L2 lakes are major reservoirs not used for public drinking water supply.

³ For designated uses see 10 CSR 20-7.031(1)(F) and 10 CSR 20-7.031 Table G. Presumed uses are assigned per 10 CSR 20-7.031(2)(A) and (B) and are reflected in the Missouri Use Designation Dataset described at 10 CSR 20-7.031(2)(E).

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1. Introduction

Missouri's Water Quality Standards include statewide numeric nutrient criteria for lakes and reservoirs that are waters of the state and have an area of at least ten acres during normal pool condition (10 CSR 20-7.031(5)(N)1.C(II)2.). Due to differences in watershed topography, soils, and geology, nutrient criteria for lakes and reservoirs are determined by use of four major lake ecoregions based upon dominant watershed ecoregion (10 CSR 20-7.031(5)(N)1.B.). The four lake ecoregions include the Big River Floodplain (Missouri Bootheel and lands directly adjacent to the Mississippi and Missouri rivers), Plains (north), Ozark Border (middle), and Ozark Highlands (south). Big River Floodplain lakes are not subject to statewide numeric nutrient criteria. Criteria for the Plains, Ozark Border, and Ozark Highlands lake ecoregions include a chlorophyll-a response impairment threshold and supplemental nutrient screening thresholds for total nitrogen (TN), total phosphorus (TP), and chlorophyll-a (Chl-a) (10 CSR 20-7.031 Tables L and M). Lakes with water quality that exceed the response impairment threshold are deemed impaired for excess nutrients (10 CSR 20-7.031(5)(N)5.). Lakes are also deemed impaired for excess nutrients if nutrient screening thresholds are exceeded and any of the five response assessment endpoints are documented in the same year (10 CSR 20-7.031(5)(N)6.).

Pomme de Terre Lake was placed on Missouri's 2022 303(d) List due to frequent exceedances of Ozark Highlands lake ecoregion TN, TP, and Chl-a nutrient screening thresholds, coupled with response assessment endpoint C (cyanobacteria) in the same year. The listing was approved by the U.S. Environmental Protection Agency (EPA) on February 13, 2024.⁴ Section 303(d) of the federal Clean Water Act and Title 40 of the Code of Federal Regulations (CFR) Part 130 require states to develop total maximum daily loads (TMDLs) for waters that do not meet applicable water quality standards. TMDLs represent the maximum amount of a pollutant that a water body can assimilate and still attain and maintain water quality standards. TMDLs are equal to the sum of wasteload allocations for point sources, load allocations for nonpoint sources, a margin of safety, and a reserve capacity. Margins of safety can be explicit (numeric) or implicit (qualitative) to account for any lack of knowledge concerning the relationship between pollutant loading and water quality, uncertainty associated with the model assumptions, or data inadequacies (40 CFR 130.7). A reserve capacity is included to allow for new facilities and any future facility expansions.

In accordance with Section 303(d) of the federal Clean Water Act, the Missouri Department of Natural Resources is establishing TN and TP TMDLs to address the listed Chl-a impairment in Pomme de Terre Lake. The 2012 version Soil and Water Assessment Tool (SWAT) was used in conjunction with version 6.1 of the BATHTUB lake eutrophication model to develop TP and TN load and target concentrations for Pomme de Terre Lake. SWAT simulates contribution of TN and TP from both point and nonpoint sources in the watershed, and BATHTUB links the wasteload allocation, load allocation, and reserve capacity to attainment of the TN, TP, and Chl-a nutrient screening thresholds in Pomme de Terre Lake (Arnold et al. 2012)(Walker 2006). The resulting nutrient TMDLs are based on precipitation and lake conditions observed in 2012, which were determined to be representative of critical low flow conditions when impairment is more likely. The nutrient targets are also protective of the load capacity and allocations assigned in the 2022 Revised TMDL for Piper Creek and Town Branch, which addresses impairments for organic sediment and unknown pollutants in some waterbodies contained within the Pomme de Terre Lake watershed.

⁴ The department maintains current and past 303(d) lists and corresponding assessment worksheets online at dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/impaired-waters.

2. Lake and Watershed Description

Pomme de Terre Lake, water body identification (WBID) 7238, is located in southwest Missouri approximately 50 miles north of Springfield and is managed for flood control by the U.S. Army Corps of Engineers. The lake is located within the Pomme de Terre basin, which is cataloged by the U.S. Geological Survey (USGS) as the 8-digit hydrologic unit code (HUC) 10290107. The lake is formed by an impoundment of the Pomme de Terre River (WBID 1440), which is the major tributary to the west branch of the lake. Lindley Creek (WBID 1436) is a major tributary to the east branch of the lake. The area of Pomme de Terre Lake is listed as 7,675 acres in 10 CSR 20-7.031 Table G, but the actual surface area varies due to flood control management and can expand to as much as 16,000 acres during periods of heavy rain (USACE 2016). The watershed contributing to Pomme de Terre Lake is approximately 631 square miles. A list of 12-digit HUC subwatersheds contained within the Pomme de Terre Lake watershed is presented in Table 1 and displayed in Figure 1.

Table 1. 12-Digit HUC subwatersheds in the Pomme de Terre watershed

HUC12	Subwatershed Name
102901070101	Headwaters Pomme de Terre River
102901070102	Spring Creek-Little Pomme de Terre River
102901070103	Selph Branch-Pomme de Terre River
102901070104	Little Wilson Creek-Pomme de Terre River
102901070201	Headwaters Lindley Creek
102901070202	Little Lindley Creek-Lindley Creek
102901070203	Brush Creek-Lindley Creek
102901070204	Ingalls Creek-Lindley Creek
102901070205	Stick Branch-Pomme de Terre Lake
102901070301	Schultz Creek-Pomme de Terre River
102901070302	Hominy Creek
102901070303	Piper Creek
102901070304	Wolf Creek-Pomme de Terre River
102901070305	Dry Fork-Pomme de Terre River
102901070306	Stinking Creek-Pomme de Terre Lake
102901070307	Decker Branch-Pomme de Terre Lake

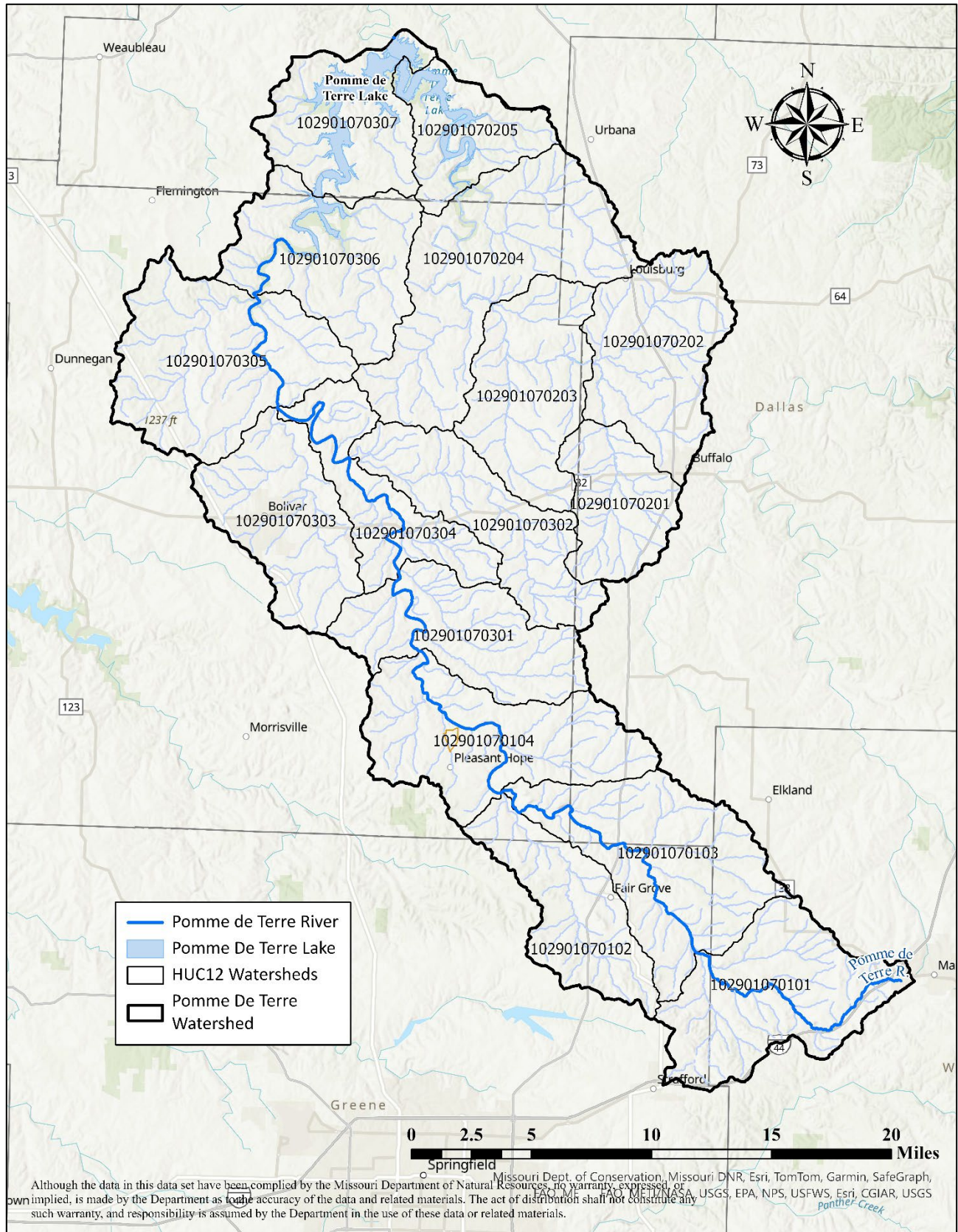


Figure 1. Pomme de Terre Lake 12-digit HUC subwatersheds

2.1 Geology, Physiography, and Soils

The Pomme de Terre Lake watershed is located within the Osage River Hills and Central Plateau ecological subsections within the Ozark/Osage ecological drainage unit (MoRAP 2005). Ecological drainage units are groups of watersheds that have similar biota, geography, and climate characteristics (USGS 2009). Within the Ozark/Osage ecological drainage unit, the Pomme de Terre Lake watershed is located in the Ozark Highlands EPA Level III ecoregion. Approximately 10 percent of the Pomme de Terre Lake watershed is within the Osage/Gasconade Hills subsection, and the southern 90 percent of the watershed is located within the Central Plateau subsection.

Ecoregions are areas with similar ecosystems and environmental resources and are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. By recognizing spatial differences in ecosystems, ecoregions stratify the environment by its probable response to disturbance (Bryce et al. 1999). Ecoregions are further defined in Missouri's Water Quality Standards at 10 CSR 20-7.031(1)(H). Lake ecoregions, as discussed in Sections 1 and 3, are defined separately at 10 CSR 20-7.031(5)(N)1.B.

The Central Plateau subsection consists of some of the least dissected portions of the Ozark Highlands. It is dominated by a thick carbonate geology consisting mainly of cherty dolomites and some prominent sandstones. Soil surface textures are mainly cherty loams or silt loams with moderate to slow infiltration rates. Fragipans are widespread in the subsoil. Relief is generally 50 to 150 feet. Floodplains tend to be narrow and not extensive, with very gravelly soils. This area is minimally dissected and many of the streams are either ephemeral or intermittent. Stream gradients are lower, substrates smaller, and waters warmer and more turbid than those found in the Osage River Hills subsection. This area was historically covered in a diverse mosaic of prairie, savanna, and open oak woodlands. Today it is largely covered in pasture and second growth timber (Chapman et al. 2002).

Soils are categorized into hydrologic soil groups based on similar runoff potentials. Each hydrologic soil group indicates the rate at which water enters the soil profile under conditions of a bare, thoroughly wetted soil surface (NRCS 2009). This infiltration rate determines the quantity of precipitation that flows over land to water bodies as direct runoff. Group A soils have the highest rate of infiltration and the lowest runoff potential. Group D soils have the lowest rate of infiltration and highest runoff potential. Many wet soils fall into dual soil groups (e.g., Group C/D) due to the presence of a seasonal high-water table that results in saturation to the soil surface. Dual hydrologic soil groups account for this condition by providing both the drained and undrained condition of the soil.⁵ Soils that are “not rated” may include areas of open water, barren lands, mining areas, and some urban areas. It should be noted that soil runoff potential is only one factor that determines the volume of runoff in a watershed. Impervious surfaces, vegetative cover, slope, rainfall intensity, and land use can significantly influence the potential for runoff regardless of the characteristics of the underlying soil. Figure 2 shows the distribution of hydrologic soil groups in the Pomme de Terre Lake watershed. Table 2 provides a summary of the hydrologic soil groups by area in square miles and relative percent.

⁵ For the purpose of hydrologic soil group, adequately drained means that the seasonal high water table is kept at least 24 inches (60 centimeters) below the surface in a soil where it would be higher in a natural state (NRCS 2009).

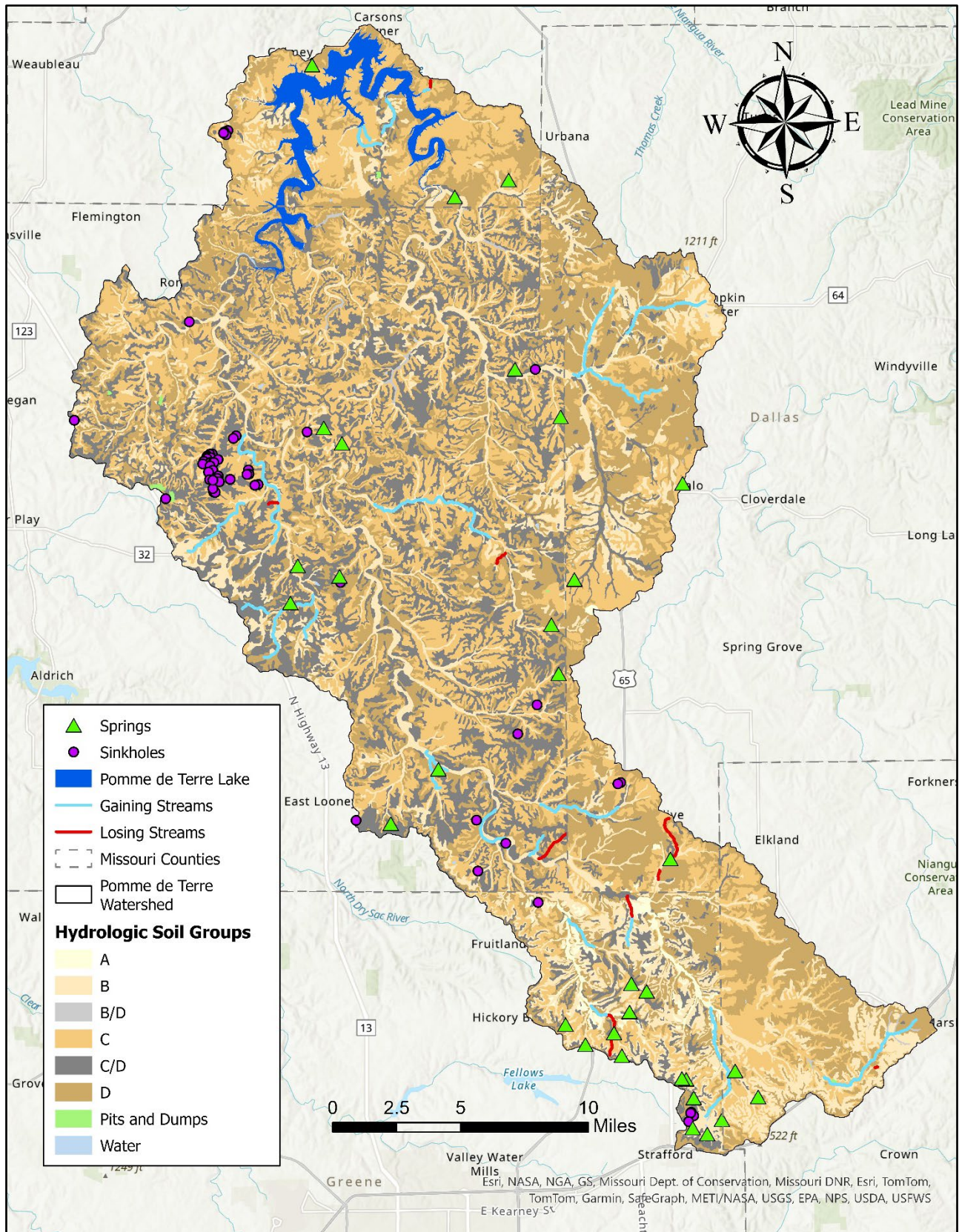


Figure 2. Hydrologic soil groups in the Pomme de Terre Lake watershed

Table 2. Hydrologic soil groups in the Pomme de Terre Lake watershed (NRCS 2020)

Hydrologic Soil Group	Area in the Watershed	
	Square miles	Percent
Group A	4.9	0.8%
Group B	103.5	16.4%
Group B/D	1.2	0.2%
Group C	199.8	31.6%
Dual Group C/D	134.4	21.3%
Group D	174.3	27.6%
Pits and Dumps	0.4	0.1%
Water	12.7	2.0%
Total	631.2*	100.0%

*Due to rounding and data resolution, this value may differ slightly from the calculated watershed area presented elsewhere in this document.

2.2 Climate

Long-term climate data is available from the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) Pomme de Terre Dam Weather Station (USC00236777), a weather station in close proximity to Pomme de Terre Lake. Climate normals were developed based on temperature and precipitation data collected at that station between 1991 and 2020 (NOAA-NCEI 2020). Precipitation normals are especially important because they relate to stream flow and runoff events that influence pollutant loading. Table 3 displays 2012 precipitation and the 30-year monthly climate normals from the Pomme de Terre Dam Weather Station for precipitation and temperature. Figure 3 is a graphical display of the data.

Table 3. Precipitation and climate at the Pomme de Terre Dam Weather Station

Month	2012* Precipitation	Precipitation Average	Minimum Temperature	Maximum Temperature
	in	in	°F	°F
January	-	1.84	23	42.3
February	2.28	2.11	25.5	47.8
March	4.05	3.15	35	57.4
April	6.22	4.89	44.9	67.2
May	3.17	5.64	55.5	75.4
June	2.31	4.92	64.8	84.0
July	1.27	4.54	69.1	88.7
August	2.39	3.99	67.1	88.0
September	4.25	4.16	58.8	80.2
October	-	3.62	47.1	70.0
November	1.07	3.26	36.2	56.5
December	1.75	2.28	27.5	45.9
	Total	Total	Average	Average
	28.76	44.4	46.2	67.0

*Data were missing for January and October in 2012

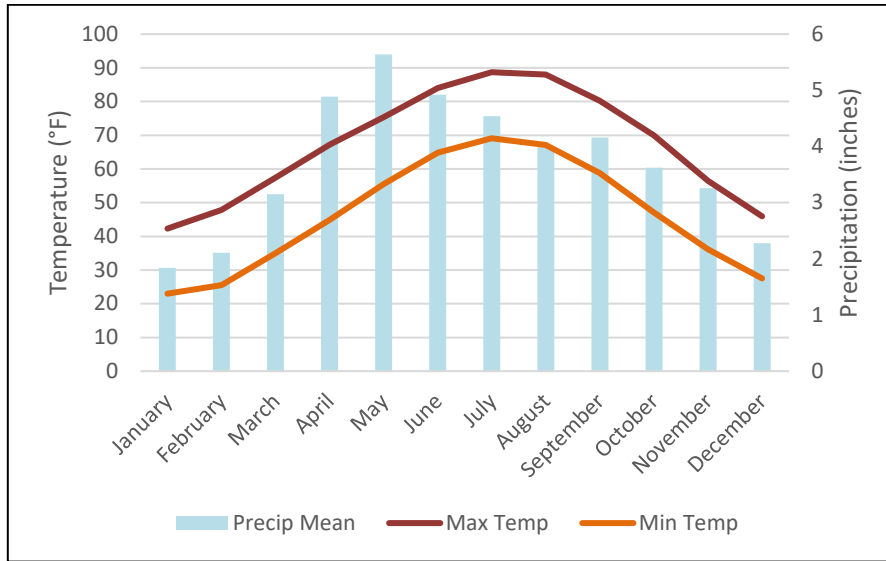


Figure 3. Monthly climate normals – Pomme de Terre Dam, MO

Between 1991 and 2020, the year 2012 had the lowest measured annual precipitation in the Pomme de Terre Lake watershed. To address the missing data from the Pomme de Terre Dam weather station, the TMDL modeling utilized interpolated precipitation data for the general Springfield area, included in Appendix D. Although precipitation amounts have been found to correlate with erosion rates at the local level (Mishra et al. 2019), rainfall intensity is more indicative of soil erosion potential than the quantity of precipitation alone. Rainfall intensity is the amount of rain that falls over time. Compared with moderate rainfall, heavy rainfall and storm rainfall are more likely to cause erosion (Meng et al. 2021). High rainfall intensity occurs when a large amount of rain falls in a short time. Climate warming models predict increases in the intensity of rainfall, especially convective rainfall, which produces short and local heavy rainfall (Martel et al. 2021).

2.3 Population

State and county population estimates are available from the U.S. Census Bureau’s 2020 census and can be localized using census block data (U.S. Census Bureau 2020). Population estimates for the Pomme de Terre Lake watershed were derived using geographic information system (GIS) software by overlaying the watershed boundary over a map of census blocks. Wherever the centroid of a census block falls within the watershed boundary, the entire population of the census block is included in the total. If the centroid of the census block is outside the boundary, the population of the entire block is excluded. As shown in Table 4, population in the Pomme de Terre Lake watershed experienced a minor increase between 2000 and 2020, consistent with overall U.S. population growth in the same time period. The population distribution in the watershed is displayed on Figure 4.

Table 4. Population estimates for the Pomme de Terre Lake watershed

Municipal			Rural			Total		
2000	2010	2020	2000	2010	2020	2000	2010	2020
13,937	15,606	16,313	20,490	23,072	22,818	34,427	38,678	39,131

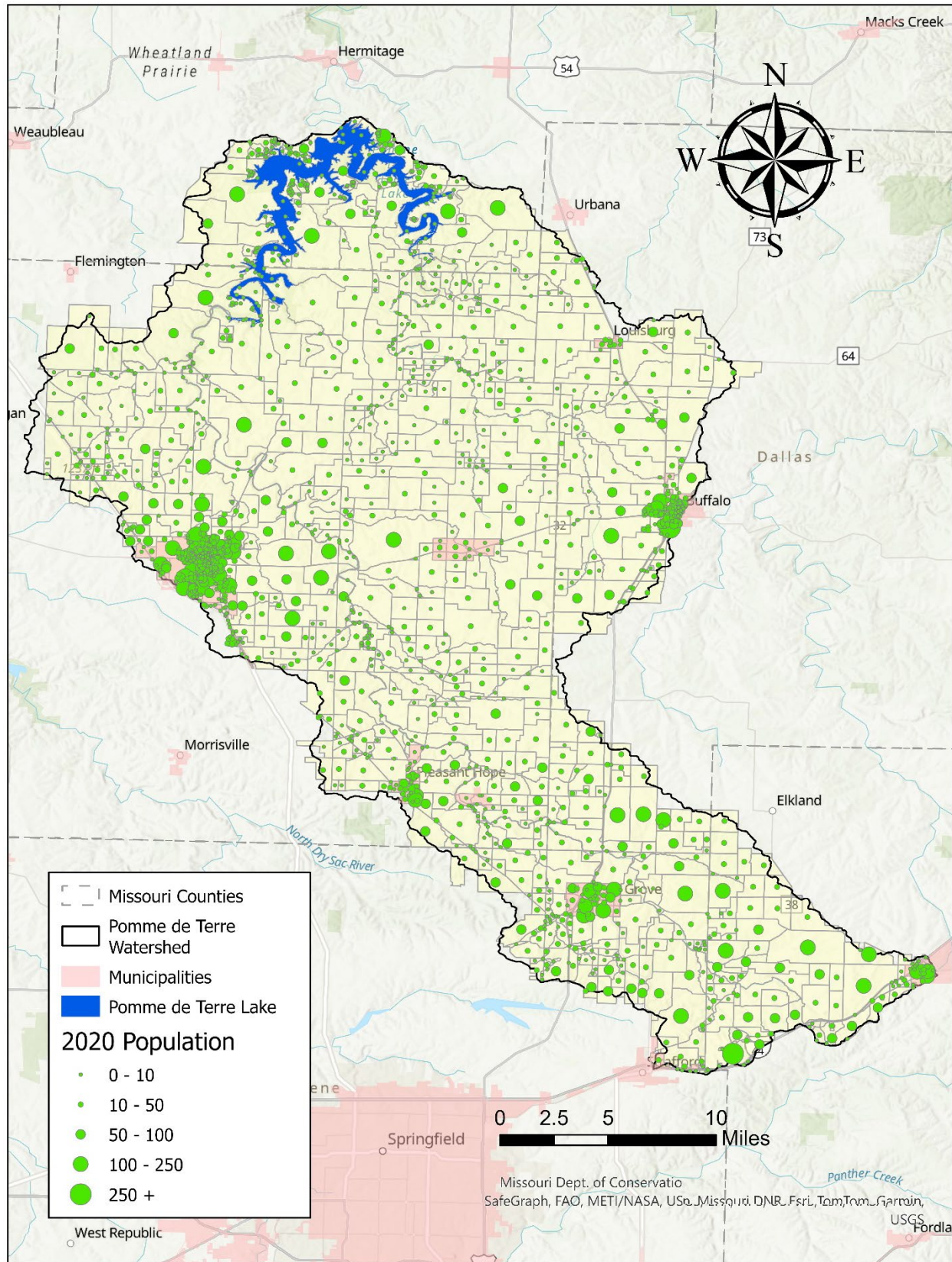


Figure 4. 2020 Population in the Pomme de Terre Lake watershed

2.4 Land Cover

A land cover analysis was completed using the 2019 National Land Cover Database published by the Multi-Resolution Land Characteristics Consortium (MRLC 2022). Land cover types present in the Pomme de Terre Lake watershed are summarized in Table 5 and displayed on Figure 5. Over 52 percent of the watershed is covered by pasture areas potentially used for livestock grazing. In total, areas with agricultural land uses account for more than 53 percent of the watershed area. Areas having urban development account for slightly less than 7 percent of the total watershed area.

Table 5. Land Cover in the Pomme de Terre Lake watershed

Land Cover Type	Area Square miles	Percent
Developed, High Intensity	1.27	0.20%
Developed, Medium Intensity	5.84	0.93%
Developed, Low Intensity	18.64	2.95%
Developed, Open Space	17.61	2.79%
Barren Land	1.07	0.17%
Cultivated Crops	7.06	1.12%
Hay/Pasture	329.17	52.16%
Forest	229.85	36.42%
Scrub and Herbaceous	5.17	0.82%
Wetlands	2.35	0.37%
Open Water	13.07	2.07%
Total*	631.10	100.00%

*Due to rounding and data resolution, this value may differ slightly from the calculated watershed area presented elsewhere in this document.

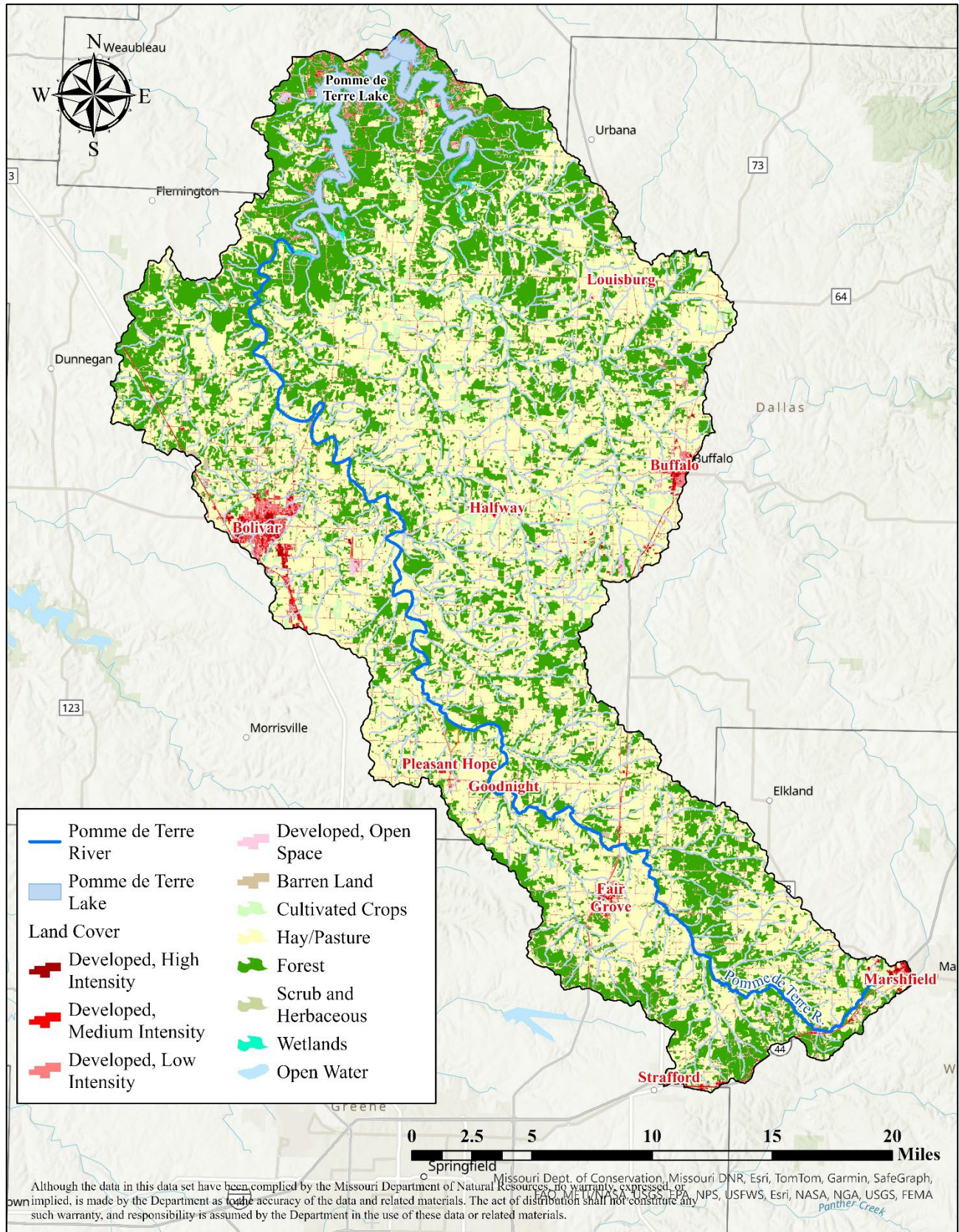


Figure 5. Land Cover in the Pomme de Terre Lake watershed

3. Applicable Water Quality Standards

TMDLs identify the maximum pollutant load that a water body can assimilate and still attain and maintain water quality standards. Water quality standards are therefore central to the TMDL development process. Under the federal Clean Water Act, every state must adopt water quality standards to protect, maintain, and improve the quality of the nation's surface waters (U.S. Code Title 33, Chapter 26, Subchapter III). Water quality standards consist of three major components: designated uses, water quality criteria, and an antidegradation policy. In accordance with federal regulations at 40 CFR 131.10, Missouri's Water Quality Standards for each individual water body also provide for the attainment and maintenance of water quality in any downstream waters. Revising existing water quality standards is not within the purview of TMDL development. If future water quality monitoring demonstrates that existing water quality standards are not protective of individual water bodies or downstream uses, new water quality standards can be proposed in accordance with the guidance provided in EPA's Water Quality Standards Handbook.⁶

3.1 Designated Uses

Missouri's Water Quality Standards at 10 CSR 20-7.031(1)(F) defines designated uses that are assigned to individual water bodies in accordance with 10 CSR 20-7.031(2) and are listed in 10 CSR 20-7.031, Table G (Lakes) and Table H (Streams). Missouri's Water Quality Standards designate the following uses to Pomme de Terre Lake:

- Warm water habitat (aquatic life)
- Human health protection
- Whole body contact recreation category A
- Secondary contact recreation
- Irrigation
- Livestock and wildlife protection

The warm water habitat (aquatic life) designated use of Pomme de Terre Lake is impaired due to exceedances of TP, TN, and Chl-a nutrient screening thresholds, coupled with demonstration of response assessment endpoint C (cyanobacteria) in the same year. The listing was approved by the EPA on August 2, 2023.

3.2 Water Quality Criteria

Water quality criteria represent a level of water quality that supports and protects particular designated uses. Missouri's Water Quality Standards include statewide numeric nutrient criteria for lakes that are waters of the state and have an area of at least ten acres during normal pool condition. Big River Floodplain lakes are not subject to statewide numeric nutrient criteria (10 CSR 20-7.031(5)(N)2.). Due to differences in watershed topography, soils, and geology, nutrient criteria for lakes and reservoirs are determined by the use of four major lake ecoregions based upon dominant watershed ecoregion (10 CSR 20-7.031(5)(N)1.B.). The four lake ecoregions include the Big River Floodplain where lake numeric nutrient criteria do not apply. The other three lake ecoregions are: Plains (north), Ozark Border (middle), and Ozark Highlands (south). Criteria for each lake ecoregion include nutrient screening thresholds for total nitrogen, total phosphorus, and Chl-a, and a Chl-a response impairment threshold concentration (10 CSR 20-7.031 Tables L and M). All TP, TN, and Chl-a concentrations must be calculated as the geometric mean of a minimum of four

⁶ <https://www.epa.gov/wqs-tech/water-quality-standards-handbook>

representative samples per year for purposes of comparison to lake ecoregion criteria thresholds. All samples must be collected from the lake surface, near the outflow of the lake, and during the period May 1 - September 30 (10 CSR 20-7.031(5)(N)4.). Lakes with water quality that exceed response impairment thresholds are deemed impaired for excess nutrients (10 CSR 20-7.031(5)(N)5.). Lakes are also deemed impaired for excess nutrients if nutrient screening thresholds are exceeded and any of the following response assessment endpoints are documented in the same year (10 CSR 20-7.031(5)(N)6.):

- A. Occurrence of eutrophication-related mortality or morbidity events for fish and other aquatic organisms;
- B. Epilimnetic excursions from dissolved oxygen or pH criteria;
- C. Cyanobacteria counts in excess of 100,000 cells per milliliter (cells/mL);
- D. Observed shifts in aquatic diversity attributed to eutrophication; and
- E. Excessive levels of mineral turbidity that consistently limit algal productivity during the period of May 1 - September 30.

Pomme de Terre Lake is subject to the numeric nutrient criteria for the Ozark Highland lake ecoregion displayed in Table 6.

Table 6. Ozark Highland Lake Ecoregion criteria

Chlorophyll-a Response Impairment Threshold (µg/L)	Nutrient Screening Thresholds (µg/L)		
	TP	TN	Chlorophyll-a
15	16	401	6

3.3 Antidegradation Policy

Missouri's Water Quality Standards include a "three-tiered" approach to antidegradation and may be found at 10 CSR 20-7.031(3).

Tier 1 – Protects public health, existing instream water uses, and a level of water quality necessary to maintain and protect existing uses. Tier 1 provides the absolute floor of water quality for all waters of the United States. Existing instream water uses are those uses that were attained on or after November 28, 1975, the date of EPA's first Water Quality Standards Regulation.

Tier 2 – Protects and maintains the existing level of water quality where it is better than applicable water quality criteria. Before water quality in Tier 2 waters can be lowered, there must be an antidegradation review consisting of: (1) a finding that it is necessary to accommodate important economic and social development in the area where the waters are located; (2) full satisfaction of all intergovernmental coordination and public participation provisions; and (3) assurance that the highest statutory and regulatory requirements for point sources and best management practices for nonpoint sources are achieved. Furthermore, water quality may not be lowered to less than the level necessary to fully protect the "fishable/swimmable" uses and other existing uses.

Tier 3 – Protects the quality of outstanding national and state resource waters. Such waters are identified in 10 CSR 20-7.031 Tables D and E. There may be no new or increased

discharges to these waters and no new or increased discharges to tributaries of these waters that would result in lower water quality.

Waters in which a pollutant is at, near, or exceeds the water quality criteria are considered in Tier 1 status for that pollutant. Therefore, the antidegradation goals for Pomme de Terre Lake are to restore water quality to levels that meet water quality standards.

4. Defining the Problem

Pomme de Terre Lake was placed on Missouri's 2022 303(d) List of Impaired Waters due to exceedances of nutrient screening thresholds coupled with an exceedance of the cyanobacteria toxin microcystin in 2021. An algal bloom observed in May 2021 corresponded with high observed microcystin levels. Lake data collected near the surface and outflow of the lake from 2017-2021 are displayed in Table 7.

Table 7. 2017-2023 Water Quality at Pomme de Terre Lake Dam

	Geometric Mean (µg/L)			Average	
	TP	TN	Chlorophyll-a	Secchi Depth (m)	Microcystin (mg/L)
May-September					
2017	29	547	13.2	1.35	0.07
2018	22	613	12.1	1.46	0.16
2019	45	567	13.5	1.38	0.18
2020	38	607	13.5	1.13	0.19
2021	49	652	12.9	1.25	87.8

The watershed contains both permitted point source dischargers and nonpoint sources of nutrients. Excessive nutrient loading can lead to increased primary production, resulting in elevated Chl-a concentrations in the receiving water body. Freshwater algal blooms can pose health concerns when harmful forms of algae or cyanobacteria (i.e., blue-green algae) are present. Certain forms of cyanobacteria have the potential to create dangerous cyanotoxins (microcystin, cylindrospermopsin, anatoxin-a, saxitoxin). These toxins can be harmful to humans, livestock, and pets. It is important to note not all cyanobacteria produce cyanotoxins. Typically, toxins are found when *Microcystis* are the predominant cyanobacteria present in the harmful algal bloom.

Generally, nonpoint source nitrogen not taken up by plants moves through watershed soils in nitrate form, reaching ditches, grass waterways, or field tiling, eventually reaching streams or lakes. Phosphorus is present in runoff in particulate, often sediment, and dissolved forms. Particulate phosphorus that travels to Pomme de Terre Lake settles on the lake bottom over time and can be a recurring internal source of phosphorus. Linear regressions of both TP and TN plotted against Chl-a are shown in Figure 6 and Figure 7, respectively. These comparisons indicate that Chl-a in Pomme de Terre Lake correlates more closely with geometric mean TP than geometric mean TN.

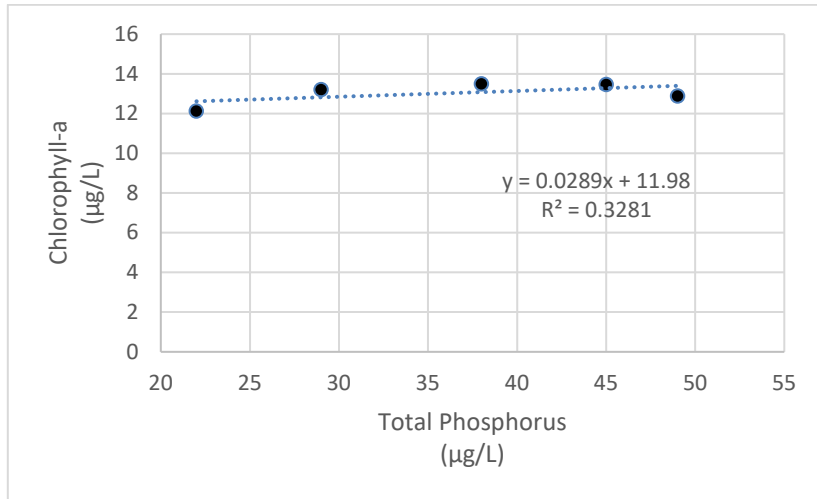


Figure 6. TP to chlorophyll-a relationship in Pomme de Terre Lake

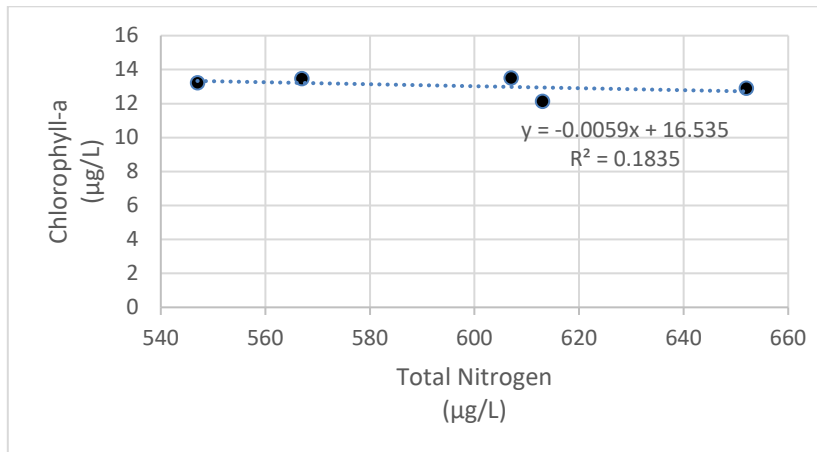


Figure 7. TN to chlorophyll-a relationship in Pomme de Terre Lake

Individual TN and TP measurements from 2017 – 2022 are provided in Appendix A, Table A-1, to illustrate the nature of the impairment. Individual measurements may be used to estimate pollutant reduction targets, to target implementation activities, and to select appropriate best management practices (BMPs). Estimated reduction targets for Pomme de Terre Lake will be presented in a supplemental nine-element watershed-based plan that will be available online at: dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/tmdls.⁷

5. Source Inventory and Assessment

Both point and nonpoint sources contribute TN and TP that can result in elevated Chl-a concentrations and excessive cyanobacteria in Pomme de Terre Lake. The following source inventory and assessment identifies and characterizes known, suspected, and potential sources of nutrient loading to Pomme de Terre Lake. Specific sources are identified and quantified to the extent that information is available.

⁷ A nine-element watershed-based plan is a type of clean water plan that provides a framework for addressing a water quality impairment through voluntary best management practices. Accepted plans are eligible for additional Section 319 funding for plan implementation, which is awarded on a competitive basis.

5.1 Point Sources

Point sources are defined by Section 644.016(16) of the Missouri Clean Water Law and are regulated pursuant to the National Pollutant Discharge Elimination System through the Missouri State Operating Permit program.⁸ A point source is defined as “any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. Point source does not include agricultural stormwater discharges and return flows from irrigated agriculture.” Based on this definition, point sources include domestic wastewater treatment facilities, industrial facilities, concentrated animal feeding operations (CAFOs), municipal separate storm sewer systems (MS4s), and stormwater discharges from industrial areas and construction sites. Illicit straight pipe discharges are also point sources but are illegal and therefore unpermitted. Pollutant loading from point sources is typically most evident during low-flow conditions when stormwater influences are lower or nonexistent. The locations of all permitted facilities within the Pomme de Terre Lake watershed can be found in Figure 8.

5.1.1 Domestic Wastewater Treatment Facilities

Domestic wastewater is primarily household waste, including graywater and sewage. Domestic wastewater treatment facilities include both publicly owned (municipal and sewer districts) and privately owned facilities. Untreated or inadequately treated domestic wastewater discharges can be significant sources of nutrients to receiving waters (USEPA 2009). Nutrients are a component of household waste. For this reason, domestic wastewater treatment facilities are potential sources of nutrient loading to Pomme de Terre Lake. Facilities that use effluent for irrigation (land application) or otherwise do not directly discharge to streams during the recreational season are not expected to cause or contribute to nutrient impairments when all permit conditions are met.

There are 21 domestic wastewater treatment facilities or plants (WWTFs or WWTPs) in the Pomme de Terre Lake watershed (Table 8). Efforts to reduce facility loading to meet newly established wasteload allocations and to comply with applicable criteria may include, but are not limited to, biological nutrient removal, chemical nutrient removal, effluent land application or irrigation, and pump and haul operations. Some lagoon systems with design flows above zero do not discharge during dry conditions and are therefore less likely to cause or contribute to the existing impairment. Of the 21 domestic facilities in the Pomme de Terre Lake watershed, two are currently in a state of non-compliance with the department. Domestic and industrial facilities in non-compliance in the Pomme de Terre Lake watershed are shown in Table 9. Although it is not known to what, if any, extent these issues of non-compliance contribute to the impairment of Pomme de Terre Lake, unpermitted discharges and discharges inconsistent with stated permit limits may result in increased pollutant loading.

⁸ The Missouri State Operating Permit program is Missouri’s program for administering the federal National Pollutant Discharge Elimination System (NPDES). Generally, the federal Clean Water Act requires all point sources that discharge pollutants to waters of the United States to obtain an NPDES permit. Issued and proposed operating permits are available online at dnr.mo.gov/water/business-industry-other-entities/permits-certification-engineering-fees/wastewater.

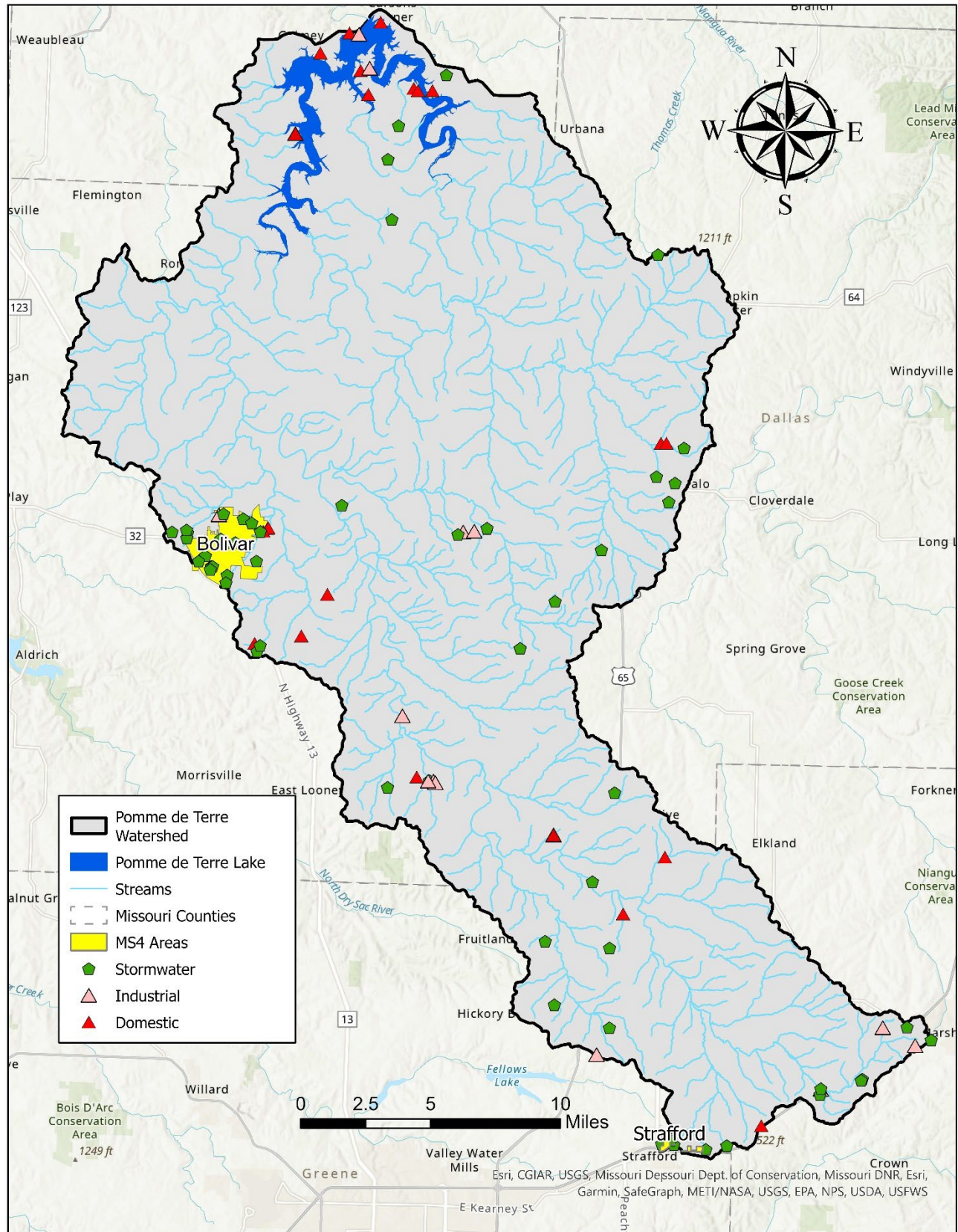


Figure 8. Permitted Facilities in the Pomme de Terre Lake watershed

Table 8. Domestic wastewater treatment facilities in Pomme de Terre Lake watershed⁹

Permit	Facility Name	Treatment Type	Design Flow (GPD)	Expires¹⁰ (Year/Mo/Day)
MO-0022373	Bolivar WWTP	Mechanical Plant	2,550,000	2029-09-30
MO-0094854	Buffalo WWTF	Mechanical Plant	700,000	2025-03-31
MO-0108308	Pleasant Hope WWTF	Lagoon	115,000	2024-12-31
MO-0111708	Fair Grove WWTF	Mechanical Plant	400,000	2024-09-30
MO-0116467	Quail Creek MHP	Lagoon	13,950	2025-06-30
MO-0121924	Karlin Place Subdivision WWTP	Sand/Rock Filter	51,000	2025-06-30
MO-0128562	Village of Halfway WWTP	Sand/Rock Filter	30,000	2024-09-30
MO-0128805	MDNR Pomme de Terre SP - Pittsburg WWTF	Land Application	No discharge	2024-12-31
MO-0132799	Sunshine Estates Subdivision HOA WWTF	Mechanical Plant	18,000	2029-09-30
MO-0132977	Ridgeview Estates WWTF	Mechanical Plant	2,750	2024-09-30
MO-0134864	Fugate MHP WWTF	Mechanical Plant	18,000	2025-03-31
MO-G823040	Goody's Resort	Land Application	No discharge	2027-08-24
MO-G823047	Acres of Shade MHP	Lagoon/Land Application	No discharge	2027-08-24
MO-G823144	Harbor Campground and Marina	Lagoon/Land Application	No discharge	2027-08-24
MO-G823151	Rustic Meadows RV Park	Subsurface Dispersal	No discharge	2027-08-24
MO-G823158	Red Bud Subdivision WWTF	No Discharge/Pump and Haul	No discharge	2027-08-24
MO-GD00133	USACE, Damsite PUA West WWTF	Mechanical Plant	10,000	2029-06-30
MO-GD00238	Whiteside Hidden Acres WWTP	Sand/Rock Filter	11,040	2029-06-30
MO-GD00457	Nemo Bridge Resort WWTP	Mechanical Plant	2,000	2029-06-30

⁹ As of January 2025¹⁰ When a NPDES permit expires, the permittee remains bound by the conditions of that expired permit until either the permit is terminated or a new permit is issued.

MO-GD00466	Silo Ridge Golf and Country Club WWTF	Sand/Rock Filter	16,830	2029-06-30
MO-GD00480	USCOE Nemo Park WWTP	Sand/Rock Filter	10,000	2029-06-30

Table 9. Facilities in non-compliance in the Pomme de Terre Lake watershed¹¹

Permit	Facility Name	Facility Type	Reason
MO-0022373	Bolivar WWTP	Domestic	Failure to upgrade facility, caused pollution to waters of the state, failure to meet permit limits
MO-0132977	Ridgeview Estates WWTF	Domestic	Operation without a required permit, failure to operate and maintain facility
MO-0113204	Missouri Prime Beef Packers	Industrial	Operation without a required permit, caused pollution to water of the state

5.1.2 Industrial Facilities

Industrial facilities, shown in Table 10, discharge process wastewater used or generated during mining, manufacturing, or food processing activities, and may also include landfills. Mining and manufacturing facilities are typically not expected to cause or contribute to nutrient impairments. Food processing wastewater may contain nutrients.

There are 13 general permitted industrial facilities and one site-specific permitted industrial facility in the Pomme de Terre Lake watershed. Missouri Prime Beef Packers (MO-0113204), formerly Moon Ridge Foods, has historically operated a meat packing plant that land applied industrial wastewater approximately 36 miles upstream of the lake in Polk County near Pleasant Hope. While in operation, Missouri Prime Beef Packers was cited for non-compliance associated with operating without a required permit and causing pollution to waters of the state. Missouri Prime Beef Packers entered into an Abatement Order on Consent (AOC) for those violations to restrict and regulate the facility and any ongoing or potential storage and operations. When last in operation, Missouri Prime Beef Packers had proposed a new discharge up to 350,000 gallons per day (GPD). That proposal has been withdrawn and the facility is not in operation, but Missouri Prime Beef Packers is included in the TMDL analysis based on an expectation for the facility to propose to resume operations at some point in the future.

Table 10. Industrial facilities in the Pomme de Terre Lake watershed¹²

Permit No.	Facility Name	Permit Description	Design Flow (GPD)	Expiration (Year/Mo/Day)
MO-G220030	Shrocks Country Butchering	Meat Processing Facility - land application	No discharge*	2027-06-30
MO-G220053	The Boucherie	Meat Packing Plants - land application	No discharge*	2027-06-30
MO-G350155	MFA Oil Bulk Plant Buffalo	Petroleum Bulk Stations and Terminals	No design flow**	2027-09-17

¹¹ Not all instances of non-compliance cause or contribute to the nutrient impairment.

¹² As of January 2025

MO-G490113	Conco Co Pittsburg Quarry	Crushed And Broken Limestone	No design flow**	2027-04-30
MO-G490247	Ewing Concrete Materials	Ready-Mixed Concrete	No design flow**	2027-04-30
MO-G490263	Bolivar Ready Mix and Materials Inc	Ready-Mixed Concrete	No design flow**	2027-04-30
MO-G490307	Northview Quarry	Crushed And Broken Limestone	No design flow**	2027-04-30
MO-G490742	Nemo Quarry LLC	Crushed And Broken Limestone	No design flow**	2027-04-30
MO-G490836	Stewart Concrete Products	Concrete Products	No design flow**	2027-04-30
MO-G490845	Conco Co Fair Grove Quarry	Crushed And Broken Limestone	No design flow**	2027-04-30
MO-G491064	Cane Creek Quarry LLC Bolivar Quarry	Crushed And Broken Limestone	No design flow**	2027-04-30
MO-G491080	Rost Ready Mix	Ready-Mixed Concrete	No design flow**	2027-04-30
MO-G500109	Cane Creek Quarry LLC Bolivar Quarry	Brick, Stone, and Related Materials	No design flow**	2027-05-22
MO-0113204	Missouri Prime Beef Packers	Meat Packing Plants	350,000***	2021-11-30

* Land application facilities not permitted to discharge to surface waters.

**Facilities permitted to discharge stormwater and/or mining process water, not assigned a design flow.

***Design flow for Missouri Prime Beef Packers is based on the most recently proposed use of the facility.

5.1.3 Concentrated Animal Feeding Operations

Pursuant to 10 CSR 20-6.300, permits are required for CAFOs that confine and feed or maintain more than 1,000 animal units for 45 days or more during any 12-month period. Permits may be required for facilities with fewer animal units if pollutants are discharged directly into waters of the state or other water quality issues are discovered. There are no permitted CAFOs present in the Pomme de Terre Lake watershed.

5.1.4 Municipal Separate Storm Sewer Systems

MS4s are stormwater conveyance systems owned by a public entity that are not part of a sanitary sewer system, a combined sewer system, or part of a domestic wastewater treatment facility. Stormwater conveyed in MS4s can carry nutrients from residential lawn fertilizer, sanitary sewer overflows, leaky septic systems, golf course runoff, pet waste, and yard waste. Federal regulations issued in 1990 require that discharges from MS4s be regulated by permits if the population of a municipality, or in some cases a county, is 100,000 or more (Phase I). As of 1999, federal regulations require permits for discharges from small MS4s that are located within a U.S. Census Bureau defined urban area or are required to hold a MS4 permit based on other criteria by the permitting authority (Phase II). MS4 permits authorize the discharge of urban stormwater runoff. Regulated MS4s in the Pomme de Terre Lake watershed are those maintained by the municipalities of Bolivar and Strafford (Figure 8 and Table 11). Additionally, the Missouri Department of Transportation (MoDOT) holds a statewide site-specific transportation separate storm sewer system

(TS4) permit (MO-0137910) that applies to stormwater discharges from MoDOT right-of-ways within the previously mentioned urban areas.

Table 11. Municipal Separate Storm Sewer Systems in the Pomme de Terre Lake watershed¹³

Permit No.	Facility Name	Permit Type	Expires (Year/Month/Day)
MOR04C022	Strafford Phase II MS4	Stormwater Small MS4	2026-09-30
MOR04C054	Bolivar Phase II MS4	Stormwater Small MS4	2026-09-30

Although stormwater discharges are often untreated, MS4 and TS4 permit holders must develop, implement, and enforce stormwater management plans to reduce the contamination of stormwater runoff and prohibit illicit discharges. Stormwater management plans must include measurable goals, annual reports, and six minimum control measures. These control measures include public education and outreach, public participation and involvement, illicit discharge detection and elimination, construction site runoff control, post-construction runoff control, and pollution prevention. MS4 and TS4 permits may also require the development of supplemental TMDL Assumptions and Requirement Attainment Plans (ARAPs) where applicable. Missouri's list of regulated MS4s and associated stormwater management plans can be accessed at: <https://dnr.mo.gov/water/business-industry-other-entities/permits-certification-engineering-fees/stormwater/municipal-separate-storm-sewer-systems-ms4>.

Approximately 5.6 square miles (0.9 percent) of the Pomme de Terre Lake watershed is contained within areas that may contribute stormwater runoff to regulated MS4s. The Bolivar Phase II MS4 was assigned TP and TN targets in the 2022 Revised TMDL for Piper Creek and Town Branch for organic sediment and unknown pollutants. Due to the relatively small proportion of area potentially contributing stormwater to these systems in the Pomme de Terre Lake watershed, these MS4s are not expected to be a significant contributor to the nutrient impairment of Pomme de Terre Lake. Unregulated urban runoff from other developed areas in the Pomme de Terre Lake watershed is considered a nonpoint source and is discussed in Section 5.2.2.

5.1.5 Other non-MS4 Permitted Stormwater Discharges

General permits are issued for certain stormwater (MOR) discharges based on the type of activity and are intended to be flexible enough to allow for ease and speed of issuance but must also protect water quality. General stormwater permits are issued for activities similar enough to be covered by a single set of requirements. Table 12 lists general stormwater discharge permits in the Pomme de Terre Lake watershed. Process wastewater is not authorized for discharge under these permits. Permits associated with construction or land disturbance activities (MORA) are temporary. The number of permits of this type may vary in any given year.

Existing and future activities for which general wastewater or stormwater permits are issued are expected to be conducted in compliance with all permit conditions including monitoring requirements and discharge limitations. Permit conditions, including setbacks, establishment of site-wide BMPs for erosion control, monitoring, and stormwater pollution prevention plans are intended to protect the designated uses of all water bodies within the watershed. For the facilities identified in Table 12, activities conducted in accordance with these general stormwater permit requirements are not expected to contribute nutrient loads in amounts substantial enough to cause or contribute to

¹³ As of January 2025

surface water impairments. Per 10 CSR 20-6.010(13)(C), if at any time the department determines that a general permit is not providing adequate water quality protection, the department may require the owner or operator of a permitted site or activity to obtain a site-specific operating permit.

Table 12. General Stormwater (MOR) permitted facilities in the Pomme de Terre Lake watershed ¹⁴

Permit	Facility	Permit Type	Expires (Year/Month/Day)
MOR203323	Superior Quality Steel Products Inc	Fabricating Metal, Light Industrial	2029-09-09
MOR203498	Tracker Marine Bolivar		2029-09-09
MOR203533	Tracker Marine Bolivar Plant 2		2029-09-09
MOR240221	Hawk Fertilizer	Agrichemical Facilities	2024-04-30
MOR60A350	Big Dog Recycling LLC	Motor Vehicle Salvage	2028-12-11
MOR60A457	Polo Auto Body and Sales		2028-12-11
MOR80C171	William E Brown	Motor Freight Transportation	2027-11-30
MOR80C407	XPO Logistics Freight Inc XSJ		2027-11-30
MOR80C529	MDNR Pomme De Terre State Park Marina		2027-11-30
MOR80C679	Harbor Campground and Marina		2027-11-30
MORA20060	The Durham Company - Buffalo Location	Land Disturbance	2027-02-07
MORA20182	Summit Park		2027-02-07
MORA20337	Wilson Logistics		2027-02-07
MORA20339	Wilson Logistics		2027-02-07
MORA20410	Tracker Marine Bolivar - Shipping Site		2027-02-07
MORA20604	Bolivar Middle School Safe Room		2027-02-07
MORA20834	Spring Hill Estates 6th Addition		2027-02-07
MORA20852	I-44 Corridor Bridge Bundle Design Build		2027-02-07
MORA21061	DCBC, L.L.C.		2027-02-07
MORA21321	Bolivar Parking Lots and Tennis Courts		2027-02-07
MORA21560	Eagle Prairie Estates Ph1-2		2027-02-07
MORA21629	Missouri Prime Beef Packers		2027-02-07
MORA21733	Food Ingredient Solutions		2027-02-07
MORA21962	Simon Square		2027-02-07
MORA22322	Open Sky Campground		2027-02-07
MORA22514	Dollar General #24764 Pittsburg MO		2027-02-07
MORA22538	James McDaniel		2027-02-07
MORA22563	Community Southern Baptist Church		2027-02-07
MORA22755	L and K Roweton Investments		2027-02-07
MORA22968	Dollar General #24991 Halfway		2027-02-07
MORA23571	Greene County Training Facility		2027-02-07
MORA23815	Fair Grove Substation		2027-02-07
MORA24597	Jordan's Place		2027-02-07
MORA24609	Swan Estates Senior Housing		2027-02-07
MORA24722	Saige Place		2027-02-07
MORA24845	Frisco Highlands at Edgewater		2027-02-07

¹⁴ As of January 2025

MORA24912	Blosser Farms	Land Disturbance	2027-02-07
MORA24916	Caseys General Store		2027-02-07
MORA25206	LLOYD DEAN ALTIC		2027-02-07
MORA25339	CMH Cancer Center		2027-02-07
MORA25670	CMH South		2027-02-07
MORA25772	Dirtworx Shop Grading		2027-02-07
MORA25786	Sharp E Business Park		2027-02-07
MORA25836	CODES - Marshfield		2027-02-07
MORA25996	Dallas County Health Department		2027-02-07
MORA26218	Chris Reynolds		2027-02-07
MORA26624	Dan Goodman Residential Development		2027-02-07
MORA26931	Premier Truck Group - Strafford		2027-02-07
MORA27252	CMH Properties - Dialysis Clinic		2027-02-07
MOR100045	City of Bolivar		2027-07-04

5.1.6 Illicit Straight Pipe Discharges

Illicit straight pipe discharges of domestic wastewater are also potential sources of nutrients. These types of sewage discharges bypass treatment systems, such as septic tanks or sanitary sewers, and discharge directly to a stream or an adjacent land area (Brown et al. 2004). Illicit straight pipe discharges are illegal and are not authorized by the federal Clean Water Act or the Missouri Clean Water Law. At present, there are no data about the presence or number of illicit straight pipe discharges in the Pomme de Terre Lake watershed. For this reason, it is unknown to what significance straight pipe discharges contribute nutrient loads to surface waters in the watershed. Due to the illegal nature of these discharges, any identified illicit straight pipe discharges must be eliminated. In areas with a regulated MS4, illicit discharge detection and elimination is a required permit condition.

5.2 Nonpoint Sources

Nonpoint sources are diffuse sources with no discernible, confined, or discrete conveyance, and include all categories of discharge that do not meet the definition of a point source. Nonpoint sources are not regulated by the federal Clean Water Act and are exempt from department permit requirements by state regulation at 10 CSR 20-6.010(1)(B)1. Nonpoint source pollutants are typically transported by stormwater runoff, which is minor or negligible during dry weather conditions. Nonpoint sources of nutrients include atmospheric deposition, agricultural lands, onsite wastewater treatment (septic) systems, and developed areas that do not have regulated storm sewer systems. Nonpoint source pollution can also result from natural background contributions, such as wildlife waste or atmospheric deposition. Streams with little to no riparian buffer are most susceptible to nonpoint source pollution. Runoff from agricultural lands used for land application of wastewater or sludge from permitted facilities, including CAFOs, is also considered a nonpoint source, so long as the activities meet agricultural practices and agronomic land application rates, without direct discharge from land application activities. The department will provide guidance and examples of BMPs to help reduce pollutant loading from nonpoint sources in a supplemental nine-element watershed-based plan that will be available at: <https://dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/tmdls>. These actions are voluntary and not a requirement of this TMDL. However, efforts to reduce pollutant loading from any potential nonpoint source contributor in the watershed is encouraged and will aid in meeting the water quality goals of this TMDL.

5.2.1 Agricultural Lands

Croplands, pasturelands, and low-density animal feeding operations are potential sources of nutrients in surface waters. Nutrients can be transported in runoff from areas where synthetic or animal manure fertilizers are applied, as well as where livestock are present. Runoff can result from precipitation or excessive irrigation. Soil and Water Conservation Districts provide funding and guidance for the development of nutrient management plans for unregulated private lands. Areas where nutrient management plans guide fertilizer application, and where BMPs are used to reduce soil erosion, contribute less nutrients to surface waters than unmanaged areas. Although grazing areas are typically well vegetated, livestock tend to congregate near feeding and watering areas, which can create barren areas that are susceptible to erosion (Sutton 1990). Additionally, livestock that are not excluded from streams will deposit manure, and thus nutrients, directly into the waterway. The exact number of livestock in the Pomme de Terre Lake watershed is unknown. Based on data from the 2012 agriculture animal count used by EPA's online input data server for the Pollutant Load Estimation Tool (PLET), livestock numbers for each 12-digit HUC watershed were estimated and reported in Table 13 (USEPA 2023). Note that livestock estimates include both pasture-raised animals and animals held in feedlots at the time of the agricultural census.

Table 13. Estimation of livestock in the Pomme de Terre Lake watershed

HUC12	Beef Cattle	Dairy Cattle	Swine	Sheep	Horse	Turkey	Chicken	Duck
102901070101	5,056	397	612	144	265	3,363	28,973	376
102901070102	2,930	111	92	25	139	2,059	281	5
102901070103	5,500	297	263	83	258	7,312	8,280	116
102901070104	7,426	316	626	101	200	20,873	669	8
102901070201	3,650	196	62	47	152	9,104	256	16
102901070202	4,702	259	38	60	205	11,536	318	23
102901070203	5,713	235	527	79	144	16,267	528	4
102901070204	7,751	329	587	98	205	19,504	647	7
102901070205	777	32	5	3	17	111	23	0
102901070301	4,991	202	482	69	121	14,314	468	2
102901070302	5,480	224	515	75	136	15,649	510	3
102901070303	5,358	214	532	74	127	15,434	507	2
102901070304	4,058	162	403	56	96	11,690	384	1
102901070305	5,791	232	575	80	137	16,680	547	2
102901070306	3,790	152	360	51	90	10,445	347	1
102901070307	1,303	54	8	5	29	158	38	0
Total	74,276	3,412	5,687	1,050	2,321	174,499	42,776	566

As noted in Section 2.4 of this document, 52 percent of the Pomme de Terre Lake watershed is pastureland and one percent of the watershed is cropland. A calibrated SWAT model was used to estimate contributions of TN and TP from agricultural runoff of pastureland and cropland in the Pomme de Terre Lake watershed. The SWAT model utilizes default manure and fertilizer rates in conjunction with land management practice data for pastureland and cropland to simulate total

nonpoint source nutrient loading at a 14-digit HUC scale. Additional information regarding the modeling inputs is included in the *Modeling Report for Pomme de Terre Lake Nutrient TMDL* included in Appendix B.

5.2.2 Runoff from Developed Areas

Developed areas where stormwater discharges are not regulated through MS4 permits can be nonpoint sources of nutrient loading. Sources of nutrient loading within such developed areas are similar to those previously described in Section 5.1.4. As presented in Section 2.4, developed areas cover small portions of the total Pomme de Terre Lake watershed. Low to high intensity development comprises approximately four percent and open space comprises approximately three percent. Degradation of water quality associated with imperviousness has been shown to first occur in a watershed at about 10 percent total imperviousness and to increase in severity as imperviousness increases (Arnold & Gibbons 1996; Schueler 1994). Due to the small amount of development in the watershed, runoff from developed areas is not expected to contribute substantial amounts of nutrients to Pomme de Terre Lake. If the developed areas are expanded in the future, BMPs and low impact development should be considered to mitigate pollutant loading from impervious surfaces.

5.2.3 Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems treat and disperse domestic wastewater on the property where it is generated. When properly designed and maintained, these systems perform well and should not contribute substantial amounts of nutrients to surface waters. However, when these systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration) there can be adverse effects to surface water quality (Horsley & Witten 1996). The Missouri Department of Health and Senior Services (DHSS) or local administrative authorities (commonly the local health department) have jurisdiction over onsite wastewater treatment systems with a design or actual flow of 3,000 gallons per day or less. Municipalities or counties may impose more stringent or additional requirements for owners of septic systems. The Missouri Department of Health and Senior Services estimates that approximately 25 percent of homes in Missouri utilize onsite wastewater treatment systems, particularly in rural areas where public sewer systems are not available (DHSS 2018). Failing onsite wastewater treatment systems can contribute nutrients to nearby streams under wet or dry weather conditions directly or through surface runoff and groundwater flows.

The exact number of onsite wastewater treatment systems in the Pomme de Terre Lake watershed is unknown. EPA's online input data server for the Pollutant Load Estimation Tool (PLET) provides estimates of septic system numbers by 12-digit HUC watersheds based on 1992 and 1998 data from the National Environmental Service Center (USEPA 2023).¹⁵ These PLET derived estimates of septic system numbers are provided in Table 14. Due to only minor fluctuations in the population of the watershed since the 2000 census, this data is assumed to provide a reasonable estimate of actual septic system numbers. The PLET input server estimates that there may be 7,514 septic systems in the watershed. Septic systems fail due to age and poor maintenance. A study by the Electric Power Research Institute (EPRI 2000) estimates septic system failure rates are 30 to 50 percent statewide.

¹⁵ The National Environmental Services Center is located at West Virginia University and maintains a clearinghouse for information related to, among other things, onsite wastewater treatment systems. Available URL: www.nesc.wvu.edu/

Nutrient contributions from septic systems to Pomme de Terre Lake are unknown. The greater the distance an onsite system is located from a surface water, the less likely it is to cause contamination (MU Extension 2023).

Table 14. PLET derived estimates of septic system numbers

Watershed Name	HUC12	Septic Systems	Population per Septic System
Headwaters Pomme de Terre River	102901070101	532	3
Spring Creek-Little Pomme de Terre River	102901070102	256	2
Selph Branch-Pomme de Terre River	102901070103	364	2
Little Wilson Creek-Pomme de Terre River	102901070104	371	2
Headwaters Lindley Creek	102901070201	340	2
Little Lindley Creek-Lindley Creek	102901070202	817	2
Brush Creek-Lindley Creek	102901070203	116	2
Ingalls Creek-Lindley Creek	102901070204	333	2
Stick Branch-Pomme de Terre Lake	102901070205	453	1
Schultz Creek-Pomme de Terre River	102901070301	117	2
Hominy Creek	102901070302	155	2
Piper Creek	102901070303	1623	2
Wolf Creek-Pomme de Terre River	102901070304	111	2
Dry Fork-Pomme de Terre River	102901070305	263	2
Stinking Creek-Pomme de Terre Lake	102901070306	170	2
Decker Branch-Pomme de Terre Lake	102901070307	896	1
Crane Creek-Pomme de Terre River	102901070401	597	1

5.2.4 Natural and Background Conditions

Natural and background sources of nutrients in the Pomme de Terre Lake watershed include atmospheric deposition, animal waste from wildlife, landscape erosion not associated with human activities, and internal loading. Natural and background contributions are included in the nonpoint source load allocation. Major sources of atmospheric phosphorus include dust from soils, ash from volcanos, combustion of oil and coal, and emissions from phosphate manufacturing (Tipping et al. 2014). Wet deposition (via precipitation) of atmospheric inorganic nitrogen (ammonium (NH_4^+), nitrite (NO_2^-), and nitrate (NO_3^-) can be a major source of nitrogen in the watershed. Volatilization of fertilizer and manure, coal-fired power plants, fertilizer manufacturers, and vehicle emissions all contribute to atmospheric nitrogen. Particulate nitrogen can remain in the air for 7-10 days, enabling it to move a good distance from the area of origin (Lassiter et al. 2023).

Wildlife such as deer, waterfowl, raccoons, rodents, and other animals contribute to the natural background concentrations of nutrients that may be found in a water body. Such contributions may be a component of runoff from agricultural areas, developed areas, forest lands, and other areas. While typical wildlife populations are not expected to cause or contribute to water body impairments, animals that congregate in large groups on or near water bodies such as geese, may contribute significant nutrient loads to surface waters. There are no watershed-specific population data for Canada geese or other waterfowl, but the Missouri Department of Conservation (MDC)

conducts statewide surveys in fall and winter. In 2020, waterfowl counts ranged from approximately 59,000 in October to 760,000 in late November (MDC 2021). The exact number of deer in the watershed is also not known, but MDC keeps harvest records by county for each hunting season. Harvest data provides a general idea of the number of deer that may be present in an area. The yearly harvests for the 2023 - 2024 season was approximately 760 in Greene County, 543 in Polk county, 434 in Hickory County, 564 in Dallas County, and 542 in Webster County (MDC 2023).

Erosion of bedrock, streambanks, and surface soil within the watershed contributes sediment to Pomme de Terre Lake. Internal loading of phosphorus occurs when phosphorus bound to lake sediment is released into the lake water. The unbinding of phosphorus from sediment occurs when lakes are stratified due to substantially different temperatures in the deep water and at the surface. Missouri lakes typically stratify in the summer. During stratification a thermal barrier (thermocline) forms isolating deep water and preventing oxygen replenishment from the atmosphere. When dissolved oxygen is low, the chemical bonds between phosphorus and metal particles in the sediment, such as iron, aluminum, and manganese, weaken and dissolved phosphorus is released into the lake water. Upon release, the phosphorus is sequestered below the thermocline where there is minimal light available. Once the surface and deep water temperatures equalize, the lake mixes vertically and the phosphorus is available at the water surface where sufficient light enables growth of algae and cyanobacteria (Williams 2016).

5.2.5 Riparian Corridor Conditions

Riparian corridor conditions have a strong influence on instream water quality. Wooded riparian buffers are a vital functional component of stream ecosystems and are instrumental in the attenuation of pollutants in runoff. Land cover within 100 feet of streams in the Pomme de Terre Lake watershed is presented in Table 15. Agricultural areas (cropland and pastureland) constitute 34.22 percent of the riparian corridors of streams in the watershed. Phosphorus loading has been shown to be highest from agricultural areas (Allafta et al. 2020). Areas that lack woody vegetation are the most susceptible to erosion, allowing nitrogen and phosphorus to enter streams with minimal interception. Establishing woody riparian corridors adjacent to agricultural areas will reduce the amount of phosphorus and nitrogen transported to Pomme de Terre Lake.

Table 15. Land Cover in Riparian Corridors in the Pomme de Terre Lake Watershed

Land Cover Type	Riparian Corridor Land Cover Type Area	
	Area Square Miles	Percent
Developed, High Intensity	0.02	0.06%
Developed, Medium Intensity	0.13	0.37%
Developed, Low Intensity	0.48	1.35%
Developed, Open Space	0.60	1.69%
Barren Land	0.01	0.03%
Cultivated Crops	0.10	0.28%
Hay/Pasture	12.03	33.94%
Forest	20.57	58.04%
Scrub and Herbaceous	0.25	0.71%
Wetlands	0.97	2.74%
Open Water	0.28	0.79%
Total:	35.44	100.00%

6. Calculating Loading Capacity

A TMDL is equal to the loading capacity of a water body for a specific pollutant, which is the maximum pollutant load that a water body can assimilate and still attain and maintain water quality standards. The loading capacity is derived from the numeric water quality criterion for each pollutant or an appropriate surrogate when no numeric criterion is applicable. Once the maximum allowable pollutant load is determined, a portion is assigned to point sources as a wasteload allocation and to nonpoint sources as a load allocation. A margin of safety is required to account for uncertainties in scientific and technical understanding of water quality in natural systems (CWA Section 303(d)(1)(C) and 40 CFR 130.7(c)(1)). The loading capacity is equal to the sum of the wasteload allocation, load allocation, margin of safety, and the reserve capacity as follows:

$$\text{TMDL} = \text{LC} = \sum \text{WLA} + \sum \text{LA} + \text{MOS} + \text{RC}$$

where LC is the loading capacity, $\sum \text{WLA}$ is the sum of the wasteload allocations, $\sum \text{LA}$ is the sum of the load allocations, MOS is the margin of safety, and RC is the reserve capacity.

7. Total Maximum Daily Loads

TMDLs for TN and TP were developed to address the listed Chl-a impairment and exceedances of nutrient screening thresholds in Pomme de Terre Lake. Target concentrations used for the TN and TP TMDLs were developed using a combined watershed and lake modeling approach calibrated to the long-term annual mean of data collected in the watershed and in Pomme de Terre Lake from 2010-2020. The resulting TN and TP target concentrations were used to develop TMDLs for TN and TP for Pomme de Terre Lake. Development methods are detailed in the *Modeling Report for Pomme de Terre Lake Nutrient TMDL* included in Appendix B. Table 16 displays the lake water quality TMDL targets.

Table 16. Lake Water Quality TMDL Targets

	TMDL Water Quality Targets ($\mu\text{g/L}$)		
	TP	TN	Chlorophyll-a
Ozark Highlands Criteria	16	401	6
East Arm Targets	10	333	5.8
West Arm Targets	15	400	4.7
Near Dam Targets	15	400	4.2

According to 40 CFR 130.2(i), TMDLs can be expressed in terms of mass per unit time, toxicity, or other appropriate measures. The TN and TP TMDLs for Pomme de Terre Lake were derived using a calibrated BATHTUB model where nonpoint sources and point sources of nutrients were reduced until all nutrient screening thresholds were attained in all three lake segments and ensures attainment of water quality standards throughout the lake. The Pomme de Terre Lake BATHTUB model yielded annual TN and TP loading values for each lake segment, which were summed to find the total annual loading capacity for the lake in pounds per year (Walker 2006). For consistency with the Anacostia Ruling (*Friends of the Earth, Inc., et al v. EPA*, No 05-5010, April 25, 2006) and EPA guidance in response to that ruling, the TMDL values were found by dividing the total annual loading capacity by 365 so that the final TMDL values would be expressed in pounds per day (USEPA 2006; USEPA 2007). The TMDL targets are protective of the warm water habitat (aquatic life) designated use and will result in attainment of water quality standards in Pomme de Terre

Lake. The TN and TP TMDLs for Pomme de Terre Lake and associated allocations are displayed in Tables 17. Specific allocations for individual sources are discussed in Sections 8 and 9.

Table 17. Pomme de Terre Lake TN and TP TMDLs

	LC*	ΣWLA	ΣLA	MOS	RC
TP (lbs/day)	49.4	27.7	14.2	4.9	2.5
TN (lbs/day)	1,054.4	366.9	529.3	105.4	52.7

* Due to rounding and the limited number of decimal places displayed, summation of the allocation values displayed may not exactly match the presented load capacity in all cases.

8. Wasteload Allocation (Point Source Load)

For this TMDL the wasteload allocation is the portion of the loading capacity assigned to existing point sources. Pursuant to 40 CFR 122.44(d)(1)(vii)(B), effluent limits or other permit conditions must be consistent with the assumptions and requirements of TMDL wasteload allocations. The wasteload allocations presented in this TMDL report do not preclude the establishment of future point sources and a separate reserve capacity (see Section 10) has been calculated to accommodate additional loading resulting from future growth or facility expansion. Any future point sources should be evaluated against the TMDL, the remaining reserve capacity, and any additional requirements associated with antidegradation.

Federal regulation 40 CFR 122.4(a), disallows the issuance of a National Pollutant Discharge Elimination System (NPDES) permit if the conditions of the permit cannot provide for compliance with the applicable requirements of the federal Clean Water Act, or regulations promulgated under the federal Clean Water Act. Additionally, 40 CFR 122.4(i) states no permit may be issued to a new source or new discharger if the discharge from its construction or operation will cause or contribute to violation of water quality standards. After undergoing antidegradation review, any new facility that discharges wastewater containing nutrients should operate in a manner that will not result in loading greater than the sum of the established wasteload allocation and reserve capacity. Decommissioning of onsite wastewater treatment systems and connecting to sewerage systems for wastewater treatment will result in net pollutant reductions that are consistent with the goals of this TMDL.

This TMDL establishes a restricted trading zone, and nutrient water quality trading consistent with the department's point or nonpoint source trading frameworks can be used as a mechanism for complying with permit limits that are established based on the wasteload allocations in this TMDL. Permitted facilities within a restricted trading zone are only authorized to acquire nutrient credits that are generated within the same watershed that the discharge is occurring. Nonpoint source credit generation can only occur once contributing nonpoint sources have achieved applicable TMDL load allocations for their land use type and area. The department provides additional resources regarding the Missouri nutrient trading program at: <https://dnr.mo.gov/water/what-were-doing/initiatives/mo-nutrient-trading-program>.

The aggregated wasteload allocations for point sources in the Pomme de Terre Lake watershed are 27.74 pounds per day (lbs/day) TP and 366.92 lbs/day TN. These allocations, summarized in Table 18, are generally based on individual facility design flows and model derived concentration targets applicable to protect warm water aquatic life habitat in Pomme de Terre Lake. Actual flows that are

less than the design flows may result in nutrient loads less than the calculated wasteload allocations. The wasteload allocations in this TMDL report do not authorize any facility to discharge pollutants at concentrations that exceed water quality standards but may accommodate additional facility loading due to population increases or expansions in service area. The wasteload allocations in this TMDL report are applicable at all flows year-round.

Table 18. Summary of Wasteload Allocations

Permit Type	WLA TP (lbs/day)	WLA TN (lbs/day)
Domestic Facilities	25.38	337.18
Industrial Facilities	2.34	29.21
MS4	0.02	0.53
CAFO	0	0
Illicit / SSO (unpermitted)	0	0
Total	27.74	366.92

8.1 Domestic Wastewater Treatment Facilities

The total wasteload allocations for domestic wastewater dischargers in the Pomme de Terre Lake watershed are 25.38 lbs/day TP and 337.18 lbs/day TN. These allocations, shown in Table 19, are generally based on individual facility design flows and model derived concentration target applicable to protect warm water aquatic life habitat in Pomme de Terre Lake. Facilities that use effluent for irrigation (land application) or otherwise do not directly discharge to streams during the recreational season are not expected to cause or contribute to nutrient impairments when all permit conditions are met and are therefore assigned wasteload allocations of zero at all flows. Sanitary sewer overflows are unpermitted discharges and are not authorized under the federal Clean Water Act. For this reason, sanitary sewer overflows in the Pomme de Terre River watershed are assigned wasteload allocations of zero at all flows. A zero wasteload allocation indicates a need for 100 percent reduction from contributing sources and is the most stringent wasteload allocation that can be assigned.

Table 19. Wasteload allocations for domestic wastewater treatment facilities

Permit	Facility	DF* (GPD)	WLA TP (mg/L)	WLA TP (lbs/day)	WLA TN (mg/L)	WLA TN (lbs/day)
MO-G823047	Acres of Shade MHP	No discharge**	0.0	0.00	0.0	0.00
MO-G823151	Rustic Meadows RV Park	No discharge**	0.0	0.00	0.0	0.00
MO-G823158	Red Bud Subdivision WWTF	No discharge**	0.0	0.00	0.0	0.00
MO-G823144	Harbor Campground and Marina	No discharge**	0.0	0.00	0.0	0.00
MO-G823040	Goody's Resort	No discharge**	0.0	0.00	0.0	0.00
MO-0128805	MDNR Pomme de Terre SP - Pittsburg WWTF	No discharge**	0.0	0.00	0.0	0.00
MO-GD00457	Nemo Bridge Resort WWTP	2,000	3.0	0.05	15.0	0.25

MO-0132977	Ridgeview Estates WWTF	2,750	3.0	0.07	15.0	0.34
MO-GD00133	USACE, Damsite PUA West WWTF	10,000	3.0	0.25	15.0	1.25
MO-GD00480	USCOE Nemo Park WWTP	10,000	3.0	0.25	15.0	1.25
MO-GD00238	Whiteside Hidden Acres WWTP	11,040	3.0	0.28	15.0	1.38
MO-0116467	Quail Creek MHP	13,950	3.0	0.35	15.0	1.75
MO-GD00466	Silo Ridge Golf and Country Club WWTF	16,830	3.0	0.42	15.0	2.11
MO-0132799	Sunshine Estates Subdivision HOA WWTF	18,000	3.0	0.45	15.0	2.25
MO-0134864	Fugate MHP WWTF	18,000	3.0	0.45	15.0	2.25
MO-0128562	Village of Halfway WWTP	30,000	3.0	0.75	15.0	3.76
MO-0121924	Karlin Place Subdivision WWTP	51,000	3.0	1.28	15.0	6.38
MO-0108308	Pleasant Hope WWTF	115,000	1.0	0.96	10.0	9.60
MO-0111708	Fair Grove WWTF	400,000	1.0	3.34	10.0	33.38
MO-0094854	Buffalo WWTF	700,000	1.0	5.84	10.0	58.42
MO-0022373	Bolivar WWTP***	2,550,000	0.5	10.64	10.0	212.81
			Total	25.38		337.18

* DF represents facility design flow.

**Land application, subsurface dispersal, or other no-discharge facilities not permitted to discharge to surface waters.

***The Bolivar WWTP WLAs for TP and TN are protective of the WLAs assigned in the revised Piper Creek and Town Branch TMDL.

8.2 Industrial Facilities

The total wasteload allocations for industrial wastewater dischargers in the Pomme de Terre Lake watershed are 2.34 lbs/day TP and 29.21 lbs/day TN. These allocations, shown in Table 20, are based on individual facility design flows and model derived concentration target applicable to protect warm water aquatic life habitat in Pomme de Terre Lake. There are 13 general permitted industrial facilities and one site-specific permitted industrial facility in the Pomme de Terre Lake watershed. Missouri Prime Beef Packers (MO-0113204), formerly Moon Ridge Foods, has historically operated a meat packing plant that land applied industrial wastewater approximately 36 miles upstream of the lake in Polk County near Pleasant Hope. The design flow for Missouri Prime Beef Packers is based on their proposed new discharge of 350,000 GPD. Activities associated with general permitted industrial facilities are not expected to contribute nutrients to surface waters. Activities for these permits are expected to be conducted in compliance with all permit conditions, including any land application, monitoring, stormwater pollution prevention plans, and discharge limitations. Permitted activities that operate in full compliance with permit conditions are not expected to contribute nutrient loads above negligible levels. For these reasons, the TN and TP wasteload allocations for general permitted industrial facilities are set at current negligible loading based on existing permit limits and conditions.

Table 20. Wasteload allocations for industrial facilities

Permit	Facility	DF (GPD)	WLA TP (mg/L)	WLA TP (lbs/day)	WLA TN (mg/L)	WLA TN (lbs/day)
MO-G220030	Shrocks Country Butchering	No discharge*	0.0	0.00	0.0	0.00
MO-G220053	The Boucherie	No discharge*	0.0	0.00	0.0	0.00
MO-G350155	MFA Oil Bulk Plant Buffalo	No design flow**	0.0	0.00	0.0	0.00
MO-G490113	Conco Co Pittsburg Quarry	No design flow**	0.0	0.00	0.0	0.00
MO-G490247	Ewing Concrete Materials	No design flow**	0.0	0.00	0.0	0.00
MO-G490263	Bolivar Ready Mix and Materials Inc	No design flow**	0.0	0.00	0.0	0.00
MO-G490307	Northview Quarry	No design flow**	0.0	0.00	0.0	0.00
MO-G490742	Nemo Quarry LLC	No design flow**	0.0	0.00	0.0	0.00
MO-G490836	Stewart Concrete Products	No design flow**	0.0	0.00	0.0	0.00
MO-G490845	Conco Co Fair Grove Quarry	No design flow**	0.0	0.00	0.0	0.00
MO-G491064	Cane Creek Quarry LLC Bolivar Quarry	No design flow**	0.0	0.00	0.0	0.00
MO-G491080	Rost Ready Mix	No design flow**	0.0	0.00	0.0	0.00
MO-G500109	Cane Creek Quarry LLC Bolivar Quarry	No design flow**	0.0	0.00	0.0	0.00
MO-0113204	Missouri Prime Beef Packers	350,000***	0.8	2.34	10.0	29.21
	Total			2.34		29.21

* Land application facilities not permitted to discharge to surface waters.

**Facilities permitted to discharge stormwater and/or mining process water not expected to contribute nutrients.

*** Design flow and WLAs for Missouri Prime Beef Packers are based on the most recently proposed use of the facility.

If the construction of the Missouri Prime Beef Packers facility does not occur as proposed, some or all of the assigned wasteload allocation will revert to the reserve capacity. The facility could retain some of the wasteload allocation in the event its actual design flow, if approved, is less than the 350,000 gpd as proposed, or it will be completely reassigned to the reserve capacity in the event the facility is not constructed at all or is constructed but is not expected to discharge.

8.3 Concentrated Animal Feeding Operations

There are no permitted CAFO facilities in the Pomme de Terre Lake watershed. CAFO facilities are subject to permit conditions that do not allow discharge directly or during land application. For this reason, the TN and TP wasteload allocations for CAFO facilities are zero at all flows. Any future CAFO facilities in the watershed must adhere to applicable no-discharge permit conditions and are not eligible to use any available reserve capacity.

8.4 Municipal Separate Storm Sewer Systems

Regulated MS4s in the Pomme de Terre Lake watershed are those maintained by the municipalities of Bolivar and Strafford. The Bolivar Phase II MS4 wasteload allocations are based on loading targets allocated in the 2022 revised TMDL for Piper Creek and Town Branch. Potential load contributions for the Strafford MS4 were calculated based on the relative area of the watershed contained within the MS4 system. The wasteload allocations for the Strafford MS4 were calculated

by multiplying the total loading capacity for the Pomme de Terre Lake watershed by the relative area within the watershed that contributes to the MS4 system. Approximately 0.29 square miles (0.05 percent) of the Pomme de Terre Lake watershed is contained within areas that may contribute stormwater runoff to the Strafford MS4. Consistent with long-standing EPA interpretation, and past draft guidance, if the area contributing to the MS4 expands or additional MS4 permits are required for stormwater discharges from other developed areas in the future, then the appropriate proportion of the load allocation, as it relates to stormwater pollutant contributions, may be re-assigned as a wasteload allocation without revision to this TMDL. The wasteload allocations for MS4s are displayed in Table 21.

Table 21. Wasteload allocations for MS4s

Permit	Facility	Area (mi ²)	WLA TP (lbs/day)	WLA TN (lbs/day)
MOR04C022	Strafford Phase II MS4	0.29	0.02	0.49
MOR04C054	Bolivar Phase II MS4	5.37	0.003	0.037
Total			0.023	0.527

8.5 Permitted Stormwater Discharges

Activities associated with other general stormwater permits described in Section 5.1.5 are not expected to contribute nutrients to surface waters, and permit conditions are protective of the designated uses assigned to all water bodies in the watersheds. Activities for which these permits are issued are expected to be conducted in compliance with all permit conditions, including any land application, monitoring, stormwater pollution prevention plans, and discharge limitations. For these reasons, the TN and TP wasteload allocations for these facilities are set at zero at all flows (Table 22). Future general and stormwater permitted activities that do not actively generate nutrients and that operate in full compliance with permit conditions are not expected to contribute nutrient loads above negligible levels and will not result in loading that exceeds the sum of the TMDL wasteload allocations. If any existing, new, or proposed general stormwater permitted facilities are found or expected to contribute nutrient loads above negligible levels, then the appropriate proportion of the reserve capacity may be re-assigned as a wasteload allocation without revision to this TMDL.

Table 22. Wasteload allocations for General Stormwater Discharges

Permit	Facility	WLA TP (lbs/day)	WLA TN (lbs/day)
MOR203323	Superior Quality Steel Products Inc	0.0	0.0
MOR203498	Tracker Marine Bolivar	0.0	0.0
MOR203533	Tracker Marine Bolivar Plant 2	0.0	0.0
MOR240221	Hawk Fertilizer	0.0	0.0
MOR60A350	Big Dog Recycling LLC	0.0	0.0
MOR60A457	Polo Auto Body and Sales	0.0	0.0
MOR80C171	William E Brown	0.0	0.0
MOR80C407	XPO Logistics Freight Inc XSJ	0.0	0.0
MOR80C529	MDNR Pomme De Terre State Park Marina	0.0	0.0
MOR80C679	Harbor Campground and Marina	0.0	0.0
MORA20060	The Durham Company - Buffalo Location	0.0	0.0

MORA20182	Summit Park	0.0	0.0
MORA20337	Wilson Logistics	0.0	0.0
MORA20339	Wilson Logistics	0.0	0.0
MORA20410	Tracker Marine Bolivar - Shipping Site	0.0	0.0
MORA20604	Bolivar Middle School Safe Room	0.0	0.0
MORA20834	Spring Hill Estates 6th Addition	0.0	0.0
MORA20852	I-44 Corridor Bridge Bundle Design Build	0.0	0.0
MORA21061	DCBC, L.L.C.	0.0	0.0
MORA21321	Bolivar Parking Lots and Tennis Courts	0.0	0.0
MORA21560	Eagle Prairie Estates Ph1-2	0.0	0.0
MORA21629	Missouri Prime Beef Packers	0.0	0.0
MORA21733	Food Ingredient Solutions	0.0	0.0
MORA21962	Simon Square	0.0	0.0
MORA22322	Open Sky Campground	0.0	0.0
MORA22514	Dollar General #24764 Pittsburg MO	0.0	0.0
MORA22538	James McDaniel	0.0	0.0
MORA22563	Community Southern Baptist Church	0.0	0.0
MORA22755	L and K Roweton Investments	0.0	0.0
MORA22968	Dollar General #24991 Halfway	0.0	0.0
MORA23571	Greene County Training Facility	0.0	0.0
MORA23815	Fair Grove Substation	0.0	0.0
MORA24597	Jordan's Place	0.0	0.0
MORA24609	Swan Estates Senior Housing	0.0	0.0
MORA24722	Saige Place	0.0	0.0
MORA24845	Frisco Highlands at Edgewater	0.0	0.0
MORA24912	Blosser Farms	0.0	0.0
MORA24916	Caseys General Store	0.0	0.0
MORA25206	LLOYD DEAN ALTIC	0.0	0.0
MORA25339	CMH Cancer Center	0.0	0.0
MORA25670	CMH South	0.0	0.0
MORA25772	Dirtworx Shop Grading	0.0	0.0
MORA25786	Sharp E Business Park	0.0	0.0
MORA25836	CODES - Marshfield	0.0	0.0
MORA25996	Dallas County Health Department	0.0	0.0
MORA26218	Chris Reynolds	0.0	0.0
MORA26624	Dan Goodman Residential Development	0.0	0.0
MORA26931	Premier Truck Group - Strafford	0.0	0.0
MORA27252	CMH Properties - Dialysis Clinic	0.0	0.0
MOR100045	City of Bolivar	0.0	0.0

8.6 Illicit Straight Pipe Discharges

Illicit straight pipe discharges are illegal and are not permitted under the federal Clean Water Act. For this reason, illicit straight pipe discharges are not allocated a portion of the available loading capacity and are assigned TN and TP wasteload allocations of zero. Any existing illicit straight pipe discharges must be eliminated, and future discharges of this type should be prevented. Illicit discharge detection and elimination is a required permit condition in areas having a regulated MS4.

9. Load Allocation (Nonpoint Source Load)

The load allocation is the portion of the loading capacity assigned to existing and future nonpoint sources and natural or background contributions (40 CFR 130.2(g)). The load allocation for this TMDL is calculated as the remainder of the loading capacity after allocations to the wasteload allocation, reserve capacity, and the margin of safety, as presented in Table 17. The load allocations include contributions from agricultural lands, runoff from developed areas, internal loading, and natural and background contributions. Natural mitigation of internal loading can be achieved by reducing TN, TP, and sediment loading from the watershed. Once TN, TP, and sediment loading from the watershed is reduced, over time, internal TN and TP will also be reduced. No portion of the load allocations is assigned to onsite wastewater treatment systems because when they are properly maintained and operating as designed, they do not discharge nutrients directly to surface waters. Additional details regarding nonpoint source load reductions will be discussed in a supplemental nine-element watershed based plan that will be available online at dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/tmdls.

10. Reserve Capacity

A portion of a TMDL's loading capacity may be set aside as a "reserve" to allow for future increases in pollutant loading. The concept of reserving loading capacity for future sources of pollutants is expressly included in the definitions of "wasteload" and "load" allocations 40 CFR 130.2(g), 40 CFR 130.2(h). Based on EPA guidance (USEPA 2012), a TMDL may assign a wasteload allocation or load allocation to a particular source that is larger than its current pollutant contribution to allow room for future loading increases by that source. A TMDL may also set aside a gross, unallocated "reserve" to account for increased future pollutant contributions from a variety of existing or future sources.

In this TMDL, an unallocated reserve capacity equal to 5 percent of the loading capacity is applied to account for potential future expansions and new discharges expected due to population growth. If a permitted discharge is terminated or reduces its permitted design flow and resultant wasteload allocation, then the remaining proportion of the wasteload allocation may be re-assigned to the reserve capacity. If any new or expanding discharges are expected to contribute nutrient loads, then the appropriate proportion of the reserve capacity may be re-assigned as a wasteload allocation without revision to this TMDL. The department will track use of the reserve capacity and ensure that the total reserve capacity in conjunction with available wasteload allocations is not exceeded. If a new or modified permit uses a portion of the reserve capacity, then the department will provide public transparency through the permit public notice process.

11. Margin of Safety

A margin of safety is required to account for uncertainties in scientific and technical understanding of water quality in natural systems (CWA Section 303(d)(1)(C) and 40 CFR 130.7(c)(1)). Based on EPA guidance (USEPA 1999), the margin of safety can be achieved through two approaches:

- Explicit - Reserve a portion of the loading capacity as a separate term in the TMDL.
- Implicit - Incorporate the margin of safety within the wasteload allocation and the load allocation calculations by making conservative assumptions in the analysis.

For this TMDL, both implicit and explicit margins of safety are used. For this TMDL, conservative assumptions serve as implicit margins of safety and are applicable during all flow conditions. The following implicit margins of safety were integrated into the development of the TMDLs for Pomme de Terre Lake:

- The model output targets for TN and TP are less than the nutrient screening thresholds;
- The Chl-a screening threshold model output target is already conservative because it is 60 percent less than the Chl-a response impairment threshold;
- The model was adjusted so the Chl-a screening threshold was attained throughout the lake, while the water quality standards compliance point is based on data collected at the dam in accordance with 10 CSR 20-7.031(5)(N)4.
- The BATHTUB model showed attainment of the screening threshold values based on the annual arithmetic mean of model outputs, rather than the seasonal geometric mean which is used in the 303(d) listing methodology. Inclusion of annual targets ensures protection during conditions when the criteria apply and impairment is most likely, as well as addresses pollutant loading throughout the year that contributes to seasonal impairments.
- The loading capacity for TN and TP was based on annual mean tributary flow inputs from the year 2012, which had the lowest measured annual precipitation in the Pomme de Terre Lake watershed for the date range of 1991 through 2020.

An explicit margin of safety equal to 10 percent of the loading capacity is applied in addition to the previously mentioned implicit margins of safety. The use of an additional explicit margin of safety of 10 percent is intended to account for differences in the outputs from calibrated models as compared to observed data as well as other unspecified and unquantified uncertainties or unknowns. Furthermore, calibrated outputs from both SWAT and BATHTUB models were all within 10 percent of mean observed data. Due to reduced uncertainty in the analysis and calculation of loading targets, along with the various implicit margins of safety outlined above, the department feels the approach used to calculate these TMDLs appropriately includes an adequate and sufficient margin of safety to fulfill the requirements of 40 CFR 130.7(c)(1). Reserving a portion of the available loading capacity as an explicit margin of safety and not allocating it to either point or nonpoint sources only further ensures that water quality standards will be achieved when all wasteload and load allocations are achieved.

12. Seasonal Variation

Federal regulations at 40 CFR 130.7(c)(1) require that TMDLs take into consideration seasonal variation in applicable water quality standards. The BATHTUB modeling used to determine the loading capacity of Pomme de Terre Lake was calibrated to data from 2010 – 2020 and rerun using precipitation and lake levels observed in 2012 to capture critical low flow conditions. The point source contribution is expected to be constant throughout the year. On the other hand, nutrient enrichment from nonpoint sources is very seasonal and depends partly on the timing of agriculture activity (soil fertilization) and rainfall events. Spring is a critical period for nonpoint source loading because it has greater rainfall, it is the growing season for most crops, and it is the time when pastures and fields are fertilized. Although the criteria is applicable during May through September, the TMDL targets are applicable year-round thus ensuring protection during that period and ensuring loading during other seasons doesn't build up in the lake to contribute during the period the criteria is applicable.

13. Monitoring Plans

The department conducts water quality monitoring in impaired waters within a reasonable timeframe following the approval of TMDLs, completion of facility upgrades and permit compliance schedules, or the implementation of watershed BMPs. The department will also routinely examine any available quality-assured water quality data collected by other local, state, and federal entities in order to assess the effectiveness of TMDL implementation. The Kansas City district of the U.S. Army Corps of Engineers actively monitors multiple locations within the lake. In addition, certain quality-assured data collected by universities, municipalities, private companies, and volunteer groups such as the Lakes of Missouri Volunteer Program and State Lake Assessment Program may be used to assess water quality following TMDL implementation. Additional detail regarding future monitoring is discussed in the supplemental nine-element plan available online at dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/tmdls.

14. Reasonable Assurance

Section 303(d)(1)(C) of the federal Clean Water Act requires that TMDLs be established at a level necessary to implement applicable water quality standards. As part of the TMDL process, consideration must be given to the assurances that point and nonpoint source allocations will be achieved and water quality standards attained. Reasonable assurance that nonpoint sources will meet their allocated amount is dependent upon the availability and implementation of nonpoint source pollutant reduction plans, controls, or BMPs within the watershed. If BMPs or other nonpoint source pollution controls allow for more stringent load allocations, then wasteload allocations can be less stringent. The TMDL process provides for nonpoint source control tradeoffs (40 CFR 130.2(i)). When a demonstration of nonpoint source reasonable assurance is developed for an impaired water body, additional pollutant allocations for point sources may be allowed provided water quality standards are still attained. If a demonstration of nonpoint source reasonable assurance does not exist, or it is determined that nonpoint source pollutant reduction plans, controls, or BMPs are not feasible, durable, or will not result in the required load reductions, then allocation of greater pollutant loading to point sources cannot occur. For this TMDL, allocations to both point and nonpoint sources are based on targets necessary to attain water quality standards. Reasonable assurance that point sources will achieve necessary pollutant reductions is provided through the NPDES and Missouri State Operating Permit program.

A variety of grants and loans may be available to assist watershed stakeholders with developing and implementing watershed-based plans, controls, and practices to meet the required wasteload and load allocations in the TMDL and demonstrate reasonable assurance. Information regarding potential funding sources, cost-share opportunities, nonpoint source nutrient reductions, and implementation actions in the Pomme de Terre Lake watershed will be provided in a supplemental nine-element plan that will be available online at dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/tmdls.

15. Public Participation

EPA regulations at 40 CFR 130.7 require that TMDLs be subject to public review. A 45-day public notice period for this TMDL report was scheduled from March 28, 2025, through May 12, 2025. Groups that directly received notice of the public comment period for this TMDL include, but are not limited to:

- Missouri Clean Water Commission;

- Missouri Department of Conservation;
- Kansas City District, U.S. Army Corps of Engineers
- County Soil and Water Conservation Districts;
- County Health Departments;
- County Commissioners;
- University of Missouri Extension;
- Missouri Coalition for the Environment;
- Missouri Farm Bureau
- Stream Teams United;
- Stream Team volunteers living in or near the watershed;
- Affected permitted entities; and
- Missouri state legislators representing areas within the watershed.

In addition to those groups directly contacted about the public notice, this TMDL report and supplemental nine-element watershed-based plan will be posted on the department's TMDL webpage dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/tmdls. All comments received during this period and the department's responses to those comments are also available at this location.

The department maintains an email distribution list for notifying subscribers of significant TMDL updates or activities, including public notices and comment periods. Those interested in subscribing to TMDL updates can submit their email address using the online form available at public.govdelivery.com/accounts/MODNR/subscriber/new?topic_id=MODNR_177.

16. Administrative Record and Supporting Documentation

The department has an administrative record on file for the Pomme de Terre Lake TMDL. The record contains plans, studies, and other information on which the TMDL is based. It additionally includes the public notice announcement, any public comments received, and the department's responses to those comments. This information is available upon request to the department at dnr.mo.gov/open-records-sunshine-law-requests. The department will process any request for information about this TMDL in accordance with Missouri's Sunshine Law (Chapter 610, RSMO) and the department's administrative policies and procedures governing Sunshine Law requests.

17. References

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Appendix A

Table A-1. Available TN and TP data from May 1 through September 30 for Pomme de Terre Lake

Year	Site Code	Site Name	TN (mg/L)	TP (mg/L)
2017	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.31	0.03
2017	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.32	0.12
2017	7238/0.3	Pomme de Terre L. at dam	0.36	0.03
2017	7238/0.3	Pomme de Terre L. at dam	0.42	0.02
2017	7238/0.5	Pomme de Terre L. near dam	0.44	0.02
2017	7238/0.5	Pomme de Terre L. near dam	0.44	0.02
2017	7238/0.5	Pomme de Terre L. near dam	0.44	0.02
2017	7238/0.5	Pomme de Terre L. near dam	0.45	0.02
2017	7238/0.6	Pomme de Terre L. 0.6 mi. from dam, 0.1 mi. southwest of small island	0.45	0.02
2017	7238/0.5	Pomme de Terre L. near dam	0.46	0.02
2017	7238/0.5	Pomme de Terre L. near dam	0.48	0.02
2017	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.48	0.05
2017	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.49	0.06
2017	7238/0.6	Pomme de Terre L. 0.6 mi. from dam, 0.1 mi. southwest of small island	0.52	0.02
2017	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.53	0.05
2017	7238/0.6	Pomme de Terre L. 0.6 mi. from dam, 0.1 mi. southwest of small island	0.53	0.02
2017	7238/2.3/1.8	Pomme de Terre Lake, Decker Arm	0.53	0.02
2017	7238/2.3/1.8	Pomme de Terre Lake, Decker Arm	0.54	0.02
2017	7238/0.5	Pomme de Terre L. near dam	0.55	0.03
2017	7238/2.3/1.8	Pomme de Terre Lake, Decker Arm	0.56	0.03
2017	7238/0.5	Pomme de Terre L. near dam	0.57	0.03
2017	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.57	0.04
2017	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.57	0.08
2017	7238/2.3/1.8	Pomme de Terre Lake, Decker Arm	0.59	0.03
2017	7238/0.3	Pomme de Terre L. at dam	0.62	0.01
2017	7238/2.3/1.8	Pomme de Terre Lake, Decker Arm	0.62	0.04
2017	7238/0.6	Pomme de Terre L. 0.6 mi. from dam, 0.1 mi. southwest of small island	0.64	0.03
2017	7238/0.6	Pomme de Terre L. 0.6 mi. from dam, 0.1 mi. southwest of small island	0.65	0.03
2017	7238/4.5	Pomme de Terre Lake 4.5 mi. ab. dam	0.66	0.02
2017	7238/0.6	Pomme de Terre L. 0.6 mi. from dam, 0.1 mi. southwest of small island	0.68	0.02

2017	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.69	0.09
2017	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.70	0.07
2017	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.71	0.06
2017	7238/0.3	Pomme de Terre L. at dam	0.74	0.04
2017	7238/2.3/1.8	Pomme de Terre Lake, Decker Arm	0.78	0.08
2017	7238/0.6	Pomme de Terre L. 0.6 mi. from dam, 0.1 mi. southwest of small island	0.81	0.07
2017	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.83	0.16
2017	7238/0.3	Pomme de Terre L. at dam	0.86	0.04
2017	7238/2.3/1.8	Pomme de Terre Lake, Decker Arm	0.89	0.06
2017	7238/0.3	Pomme de Terre L. at dam	0.90	0.07
2017	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.90	0.04
2018	7238/0.3	Pomme de Terre L. at dam	0.32	0.03
2018	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.40	0.04
2018	7238/0.3	Pomme de Terre L. at dam	0.45	0.02
2018	7238/0.5	Pomme de Terre L. near dam	0.52	0.02
2018	7238/0.6	Pomme de Terre L. 0.6 mi. from dam, 0.1 mi. southwest of small island	0.52	0.02
2018	7238/0.5	Pomme de Terre L. near dam	0.53	0.02
2018	7238/0.5	Pomme de Terre L. near dam	0.54	0.02
2018	7238/0.6	Pomme de Terre L. 0.6 mi. from dam, 0.1 mi. southwest of small island	0.55	0.02
2018	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.56	0.05
2018	7238/0.6	Pomme de Terre L. 0.6 mi. from dam, 0.1 mi. southwest of small island	0.59	0.02
2018	7238/0.6	Pomme de Terre L. 0.6 mi. from dam, 0.1 mi. southwest of small island	0.59	0.02
2018	7238/0.6	Pomme de Terre L. 0.6 mi. from dam, 0.1 mi. southwest of small island	0.59	0.02
2018	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.59	0.03
2018	7238/2.3/1.8	Pomme de Terre Lake, Decker Arm	0.59	0.02
2018	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.60	0.05
2018	7238/2.3/1.8	Pomme de Terre Lake, Decker Arm	0.61	0.03
2018	7238/0.6	Pomme de Terre L. 0.6 mi. from dam, 0.1 mi. southwest of small island	0.62	0.02
2018	7238/2.3/1.8	Pomme de Terre Lake, Decker Arm	0.64	0.02
2018	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.66	0.03
2018	7238/2.3/1.8	Pomme de Terre Lake, Decker Arm	0.66	0.02
2018	7238/0.5	Pomme de Terre L. near dam	0.68	0.02
2018	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.68	0.10
2018	7238/0.3	Pomme de Terre L. at dam	0.70	0.02

2018	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.70	0.03
2018	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.77	0.07
2018	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.85	0.07
2018	7238/0.6	Pomme de Terre L. 0.6 mi. from dam, 0.1 mi. southwest of small island	0.88	0.02
2018	7238/0.3	Pomme de Terre L. at dam	1.00	0.03
2018	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	1.00	0.11
2018	7238/0.6	Pomme de Terre L. 0.6 mi. from dam, 0.1 mi. southwest of small island	1.06	0.07
2018	7238/10.0	Pomme de Terre L. S of Hwy. RB	1.19	0.11
2018	7238/0.3	Pomme de Terre L. at dam	1.20	0.04
2018	7238/10.0	Pomme de Terre L. S of Hwy. RB	1.20	0.09
2018	7238/0.3	Pomme de Terre L. at dam	1.25	0.09
2018	7238/0.3	Pomme de Terre L. at dam	1.58	0.21
2018	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	2.04	0.64
2018	7238/10.0	Pomme de Terre L. S of Hwy. RB	2.40	0.73
2019	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.39	0.03
2019	7238/0.3	Pomme de Terre L. at dam	0.41	0.06
2019	7238/0.5	Pomme de Terre L. near dam	0.42	0.02
2019	7238/0.3	Pomme de Terre L. at dam	0.43	0.03
2019	7238/0.3	Pomme de Terre L. at dam	0.47	0.07
2019	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.47	0.03
2019	7238/0.5	Pomme de Terre L. near dam	0.48	0.03
2019	7238/2.3/1.8	Pomme de Terre Lake, Decker Arm	0.48	0.02
2019	7238/0.5	Pomme de Terre L. near dam	0.49	0.02
2019	7238/0.5	Pomme de Terre L. near dam	0.50	0.02
2019	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.53	0.07
2019	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.53	0.10
2019	7238/0.5	Pomme de Terre L. near dam	0.54	0.03
2019	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.56	0.05
2019	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.56	0.08
2019	7238/0.5	Pomme de Terre L. near dam	0.58	0.03
2019	7238/2.3/1.8	Pomme de Terre Lake, Decker Arm	0.58	0.03
2019	7238/0.3	Pomme de Terre L. at dam	0.61	0.07
2019	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.68	0.09
2019	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.72	0.06
2019	7238/0.5	Pomme de Terre L. near dam	0.98	0.09
2019	7238/0.3	Pomme de Terre L. at dam	1.00	0.09

2019	7238/10.0	Pomme de Terre L. S of Hwy. RB	1.05	0.08
2019	7238/0.5	Pomme de Terre L. near dam	1.10	0.09
2019	7238/10.0	Pomme de Terre L. S of Hwy. RB	1.14	0.20
2019	7238/0.6	Pomme de Terre L. 0.6 mi. from dam, 0.1 mi. southwest of small island	1.18	0.05
2019	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	1.21	0.14
2019	7238/0.3	Pomme de Terre L. at dam	1.22	0.07
2019	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	1.24	0.09
2019	7238/0.6	Pomme de Terre L. 0.6 mi. from dam, 0.1 mi. southwest of small island	1.38	0.07
2020	7238/0.3	Pomme de Terre L. at dam	0.44	0.01
2020	7238/0.5	Pomme de Terre L. near dam	0.48	0.04
2020	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.51	0.08
2020	7238/0.3	Pomme de Terre L. at dam	0.52	0.05
2020	7238/0.5	Pomme de Terre L. near dam	0.52	0.03
2020	7238/0.3/1.0/1.4/1.4	Pomme De Terre L. central arm	0.55	0.03
2020	7238/0.5	Pomme de Terre L. near dam	0.55	0.03
2020	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.56	0.04
2020	7238/0.5	Pomme de Terre L. near dam	0.60	0.04
2020	7238/0.5	Pomme de Terre L. near dam	0.61	0.03
2020	7238/0.5	Pomme de Terre L. near dam	0.62	0.02
2020	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.63	0.06
2020	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.63	0.08
2020	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.64	0.06
2020	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.65	0.04
2020	7238/0.3	Pomme de Terre L. at dam	0.71	0.05
2020	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.76	0.16
2020	7238/0.5	Pomme de Terre L. near dam	0.79	0.04
2020	7238/0.5	Pomme de Terre L. near dam	0.81	0.05
2020	7238/0.3/1.0/1.4/1.4	Pomme De Terre L. central arm	0.86	0.06
2020	7238/0.3	Pomme de Terre L. at dam	0.87	0.12
2020	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	1.24	0.11
2021	7238/0.3	Pomme de Terre L. at dam	0.58	0.08
2021	7238/0.3	Pomme de Terre L. at dam	0.59	0.07
2021	7238/0.3	Pomme de Terre L. at dam	0.62	0.09
2021	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.67	0.10
2021	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.69	0.07
2021	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.76	0.08

2021	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.76	0.08
2021	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.78	0.10
2021	7238/0.3	Pomme de Terre L. at dam	0.81	0.09
2021	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.81	0.10
2021	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.83	0.11
2021	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.84	0.12
2021	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.94	0.11
2021	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.98	0.14
2021	7238/0.3	Pomme de Terre L. at dam	1.01	0.11
2021	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	1.04	0.08
2021	7238/10.0	Pomme de Terre L. S of Hwy. RB	1.21	0.19
2021	7238/0.3	Pomme de Terre L. at dam	1.25	0.09
2021	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	1.30	0.09
2021	7238/0.3	Pomme de Terre L. at dam	3.06	0.69
2021	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	3.26	0.79
2022	7238/0.3	Pomme de Terre L. at dam	0.42	0.12
2022	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.55	0.14
2022	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.62	0.14
2022	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.62	0.13
2022	7238/0.3	Pomme de Terre L. at dam	0.69	0.03
2022	7238/0.3	Pomme de Terre L. at dam	0.70	0.04
2022	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.70	0.09
2022	7238/0.5/8.0/0.5	Pomme de Terre Lake @ CR 306	0.76	0.05
2022	7238/0.3	Pomme de Terre L. at dam	0.78	0.10
2022	7238/0.5/5.8/0.22	Pomme de Terre Lake near Nemo Park Swim Beach - inside of barriers	0.79	0.12
2022	7238/0.3	Pomme de Terre L. at dam	0.80	0.08
2022	7238/0.3	Pomme de Terre L. at dam	0.80	0.06
2022	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.81	0.13
2022	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.83	0.07
2022	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.83	0.08
2022	7238/0.5/5.8/0.17	Pomme de Terre Lake near Nemo Park Swim Beach - outside of barriers	0.86	0.06
2022	7238/0.3	Pomme de Terre L. at dam	0.87	0.11
2022	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.92	0.11
2022	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	0.93	0.08

2022	7238/10.0	Pomme de Terre L. S of Hwy. RB	0.93	0.09
2022	7238/0.5/6.0	Pomme de Terre L. acr. From Nemo Park	1.04	0.12
2022	7238/10.0	Pomme de Terre L. S of Hwy. RB	1.18	0.17
2022	7238/0.5/6.4/0.2	Pomme de Terre Lake near Nemo Park Boat Ramp	E1.78	0.14

Appendix B

Modeling Report for Pomme de Terre Lake Nutrient TMDL

Overview

Pomme de Terre Lake was placed on Missouri’s 2022 303(d) List due to frequent exceedances of Ozark Highlands ecoregion total nitrogen (TN), total phosphorus (TP), and chlorophyll-a (Chl-a) nutrient screening thresholds, coupled with response assessment endpoint C (cyanobacteria) in the same year. The listing was approved by the U.S. Environmental Protection Agency (EPA) on August 2, 2023.¹⁶ Pomme de Terre Lake, water body identification (WBID) 7238, is located in southwest Missouri approximately 50 miles north of Springfield. The lake is located within the Pomme de Terre basin, which is cataloged by the U.S. Geological Survey (USGS) as the 8-digit hydrologic unit code (HUC) 10290107.

Section 303(d) of the federal Clean Water Act and Title 40 of the Code of Federal Regulations (CFR) Part 130 require states to develop total maximum daily loads (TMDLs) for waters that do not meet applicable water quality standards. TMDLs represent the maximum amount of a pollutant that a water body can assimilate and still attain and maintain water quality standards. TMDLs are equal to the sum of wasteload allocations for point sources, load allocations for nonpoint sources, and a margin of safety (40 CFR 130.7). A reserve capacity to account for future point sources may also be included.

The Missouri Department of Natural Resources is seeking to establish TN and TP TMDLs to address the Chl-a impairment listed for Pomme de Terre Lake. Two separate models were calibrated and linked together to characterize point and nonpoint source nutrient loads during average conditions. The Soil and Water Assessment Tool (SWAT) Version 2012/Rev 692 was used to model average watershed flow and nutrient loads which were then input into BATHTUB Version 6.14 and calibrated to observed average TN, TP, and Chl-a concentrations in Pomme de Terre Lake. The calibrated models were then adjusted to simulate critical conditions under various nutrient reduction scenarios to establish final nutrient TMDLs.

SWAT Model Setup

The Pomme de Terre Lake watershed SWAT model was set up using the Hydrologic and Water Quality System (HAWQS) Version 2.0 BETA user interface. HAWQS is a web-based interactive water quantity and water quality modeling system that employs SWAT as its core modeling engine. HAWQS provides users with interactive web interfaces and maps; pre-loaded input data; outputs that include tables, charts, and graphs; a user’s guide, and online development, execution, and storage of a user’s modeling projects. The EPA Office of Water supports and provides project management and funding for HAWQS. The Texas A&M University Spatial Sciences Laboratory and EPA subject matter experts provide ongoing technical support including system design, modeling, and software development. The U.S. Department of Agriculture and Texas A&M University jointly developed SWAT and have actively supported the model for more than 25 years (USEPA, 2017). The Pomme de Terre Lake SWAT model was developed at the HUC14 watershed scale and encompasses 78 HUC14 subbasins, shown in Figure B1.

¹⁶ The department maintains current and past 303(d) lists and corresponding assessment worksheets online at: dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/impaired-waters.

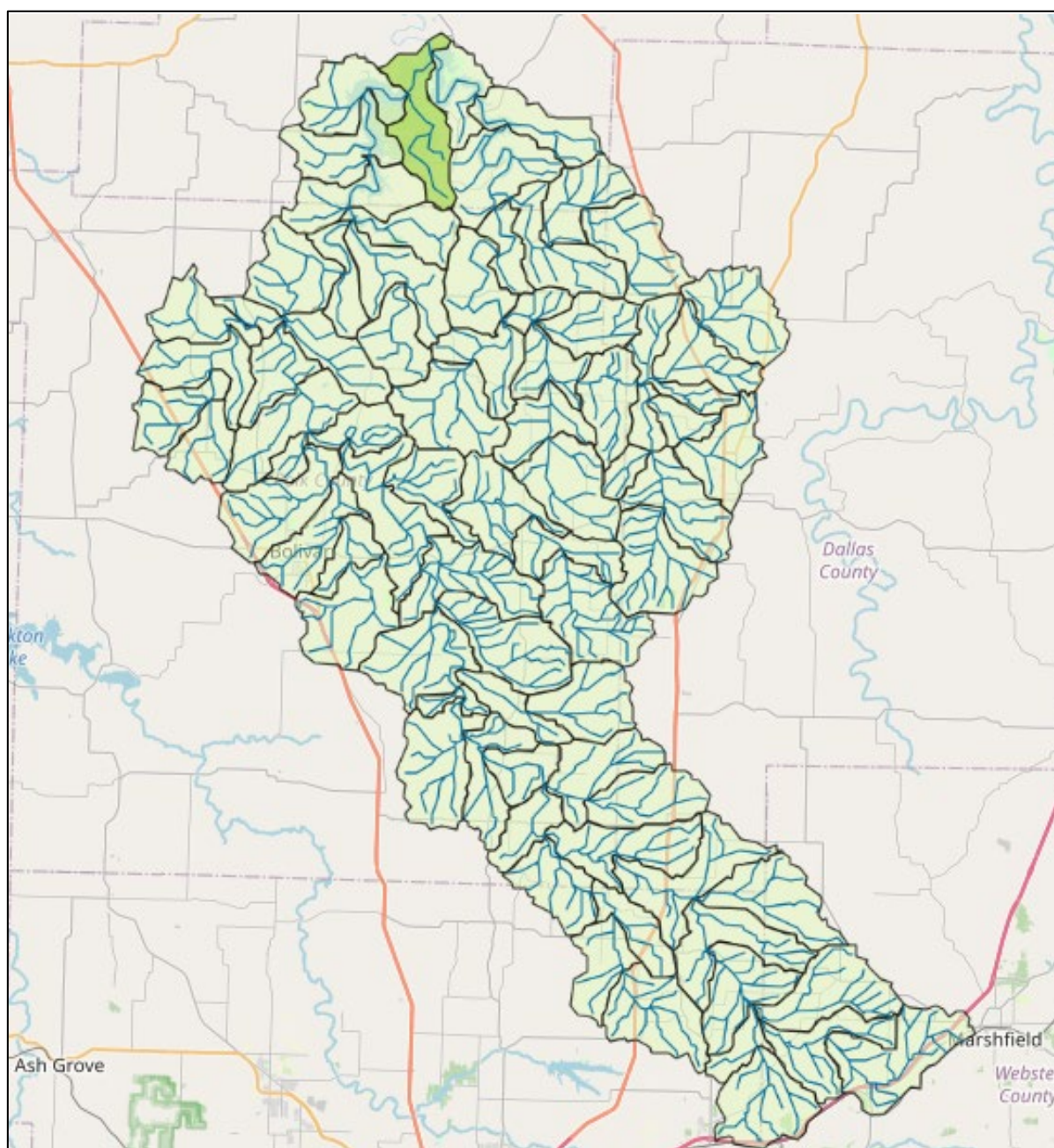


Figure B1. SWAT Model HUC14 Subbasins

The subbasins were further subdivided into hydrologic response units (HRUs) which contain similar soil, slope, and land use. The initial model setup resulted in 8,472 distinct HRUs which were then reduced to 503 HRUs by applying a 1.00 km² minimum area threshold. Any HRU with less than 1.00 km² area was automatically redistributed into nearby HRUs in the HRU aggregation process. After aggregation, 66.4 percent of the watershed was occupied by pasture and 30.2 percent by deciduous forest. A summary of the HRU land use before and after aggregation is presented in Table B1. Detailed HRU inputs are included in Appendix C, Table C1.

Table B1. Pomme de Terre Lake watershed land use by HRU

Land Use code	Land Use	Land use with area threshold applied		Default HRU Land Use	
		Area	% of Total Area	Area	% of Total Area
PAST	Pasture	1,085.36 km ²	66.41 %	863.13 km ²	52.82 %
FRSD	Deciduous Forest	494.11 km ²	30.24 %	484.76 km ²	29.66 %
FRST	Mixed Forest	-	-	110.54 km ²	6.76 %
FRSE	Evergreen Forest	-	-	35.51 km ²	2.17 %
URLD	Urban Low Density	11.20 km ²	0.69 %	32.58 km ²	1.99 %
SOYB	Soybean	-	-	13.92 km ²	0.85 %
FESC	Tall Fescue	-	-	10.30 km ²	0.63 %
CORN	Corn	-	-	7.78 km ²	0.48 %
URMD	Urban Medium Density	-	-	6.97 km ²	0.43 %
RNGE	Range Grasses	-	-	6.16 km ²	0.38 %
RNGB	Range Bush	-	-	4.20 km ²	0.26 %
AGRR	Agricultural Row Crops	-	-	3.99 km ²	0.24 %
RIWF	Forested Riparian Wetlands	3.39 km ²	0.21 %	3.39 km ²	0.21 %
WATR	Water	3.31 km ²	0.20 %	3.31 km ²	0.20 %
RYE	Rye	-	-	3.14 km ²	0.19 %
BARR	Barren	-	-	2.88 km ²	0.18 %
URHD	Urban High Density	-	-	1.89 km ²	0.12 %
RIWN	Non-forested Riparian Wetlands	1.69 km ²	0.10 %	1.69 km ²	0.10 %
UPWN	Non-forested Isolated Wetlands	1.15 km ²	0.07 %	1.15 km ²	0.07 %
ALFA	Alfalfa	-	-	1.04 km ²	0.06 %
GRSG	Grain Sorghum	-	-	0.71 km ²	0.04 %
COSY	Corn Soybean double crop	-	-	0.49 km ²	0.03 %
WWSR	Winter Wheat Sorghum	-	-	0.36 km ²	0.02 %
WWHT	Winter Wheat	-	-	0.32 km ²	0.02 %
UPWF	Forested Isolated Wetlands	0.14 km ²	0.01 %	0.14 km ²	0.01 %

SWAT Model Flow Calibration

The Pomme de Terre Lake SWAT model was run for a simulation time period of January 1, 2007, to December 31, 2019, with a three-year warm-up period, and was calibrated to stream flow, TN, and TP over a ten-year period spanning 2010 – 2020. The model was run with a daily output setting. Initial calibration rates were based on values from a previously calibrated SWAT model developed for HUC1101003, and with additional minor adjustment to improve flow and TP calibration. The rate adjustments in the calibration model are shown below in Table B2.

Table B2. SWAT calibration adjustments

Category	Coefficient Values
Basin adjustments (all HRUs)	SFTMP: -0.43 SMTMP: 0.32 SMFMX: 3.53 SMFMN: 3.38 TIMP: 0.36 ESCO: 0.8 EPCO: 0.8

	CNCOEF: 0.7 SURLAG: 1 PPERCO: 10 PHOSKD: 200 TRNSRCH: 0.15 EVRCH: 0.7
Cn2Percent adjustment (all HRUs)	value: -3
Agricultural Management (HRUs containing pasture)	USLE_P: 0.7 FILTERW: 2

The HAWQS user interface automatically populates the SWAT model with default point source loads based on data from the water quality exchange maintained by EPA. These point source values were reviewed and adjusted when there was a substantial difference in the default flow from the permitted actual flow. Edits were made based on observed actual flows to the default flow in the calibration model for four facilities, presented in Table B3. Detailed point source load inputs by HUC14 subbasin are included in Appendix C, Table C3. The respective nutrient loads were adjusted proportional to the change in the flow. The resultant loads were summed with the remaining default loads to calculate total loads by subbasin.

Table B3 Facilities Adjusted in the Calibrated SWAT Model

Permit	Facility Name	HUC14	Design Flow gpd	Actual Flow gpd
MO0111708	Fair Grove WWTP	10290107010302	400,000	352,000
MO0094854	Buffalo WWTF	10290107020206	700,000	1,016,000
MOGD00480	USCOE Nemo Park (May-Sept Only)	10290107020502	10,000	360
MO0128562	Village of Halfway	10290107030203	30,000	10,000

The SWAT flow calibration was performed by comparing the average monthly flow output to observed average monthly flow data at USGS gages 06921070 on the Pomme de Terre River (Figure B2) and 06921200 on Lindley Creek (Figure B3).

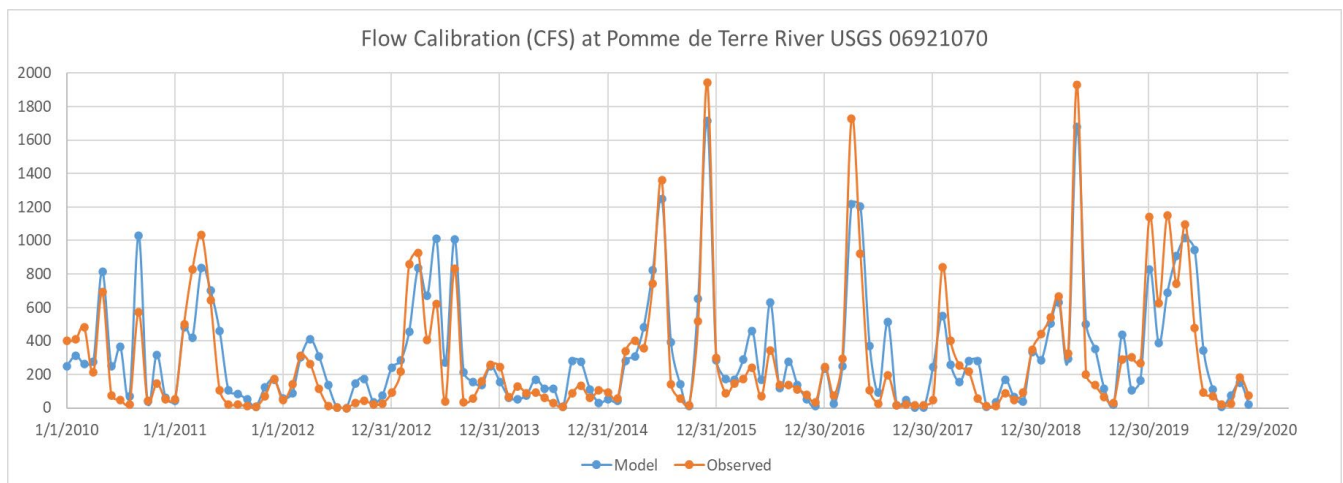


Figure B2. SWAT Flow Calibration for Pomme de Terre River

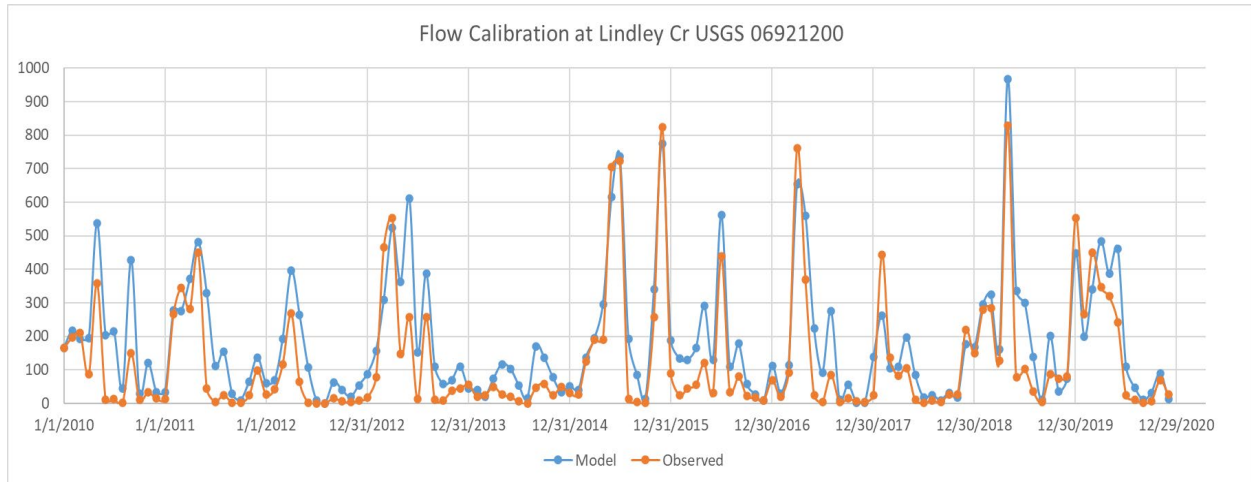


Figure B3. SWAT Flow Calibration for Lindley Creek

SWAT Model Water Quality Calibration

The SWAT model was calibrated to TP and TN data collected on the Pomme de Terre River near Polk by USGS (Gage 06921070). Daily modeled nutrient concentration outputs from HUC10290107030401 were compared to observed grab samples collected on the same day and used to inform calibration rate adjustments. TP calibration is presented in Figure B4 and TN calibration is presented in Figure B5.

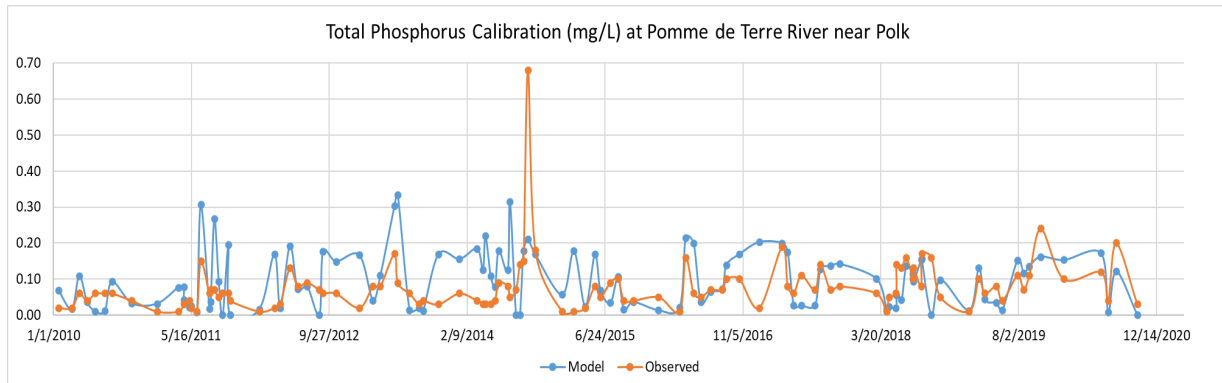


Figure B4. SWAT Total Phosphorus Calibration

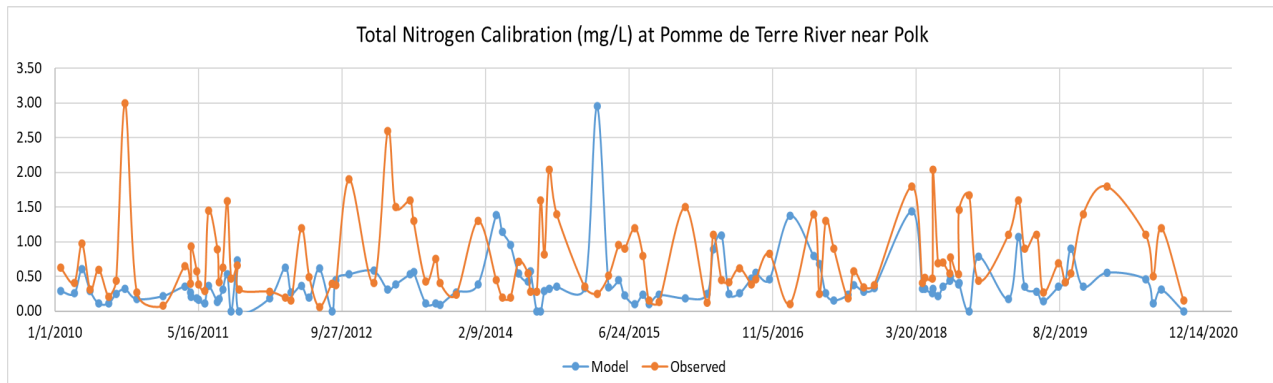


Figure B5. SWAT Total Nitrogen Calibration

Calibration was further confirmed by comparing the mean modeled loads to the observed annual mean flow-weighted loads for both TN and TP, shown in Table B4. To calculate a flow weighted TN concentration, a regression was developed comparing flow to observed TN, shown in Figure B6. Figure B7 shows the predicted daily TN loads from 2010 to 2020 as blue lines, with the observed loads plotted as points. Note this calibration dataset differs from the dataset discussed in Section 4 of the TMDL which was used to determine impairment status of Pomme de Terre Lake. Water quality data from 2010 to 2020 were used in model calibration because they overlap the last 10 years of climate data used in the current monthly climate normal, and because this time period includes both wet and dry years. The calibration time period also includes 2012 which had the lowest measured annual precipitation in southwest Missouri during this timeframe. Monthly precipitation data are included in Appendix D

Table B4. Observed and modeled flow-weighted load comparisons

Observed flow-weighted TN (mg/L)	Modeled flow-weighted TN (mg/L)	Observed flow-weighted TP (mg/L)	Modeled flow-weighted TP (mg/L)
0.89	0.84	0.18	0.17

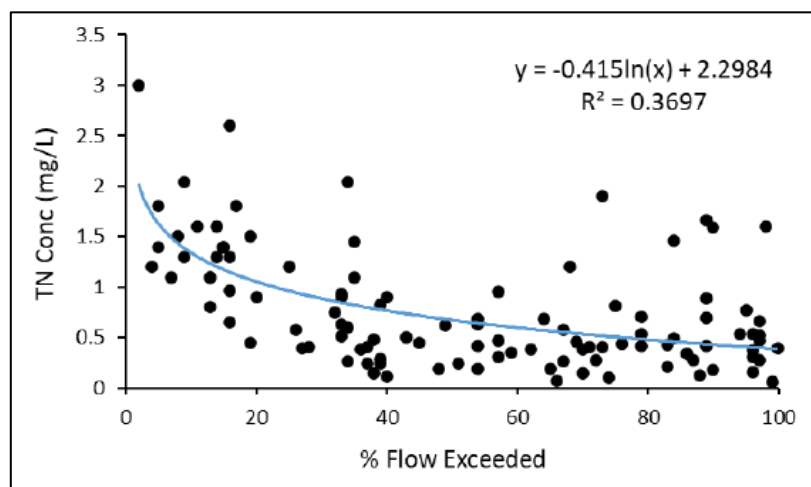


Figure B6. TN flow exceedance comparison

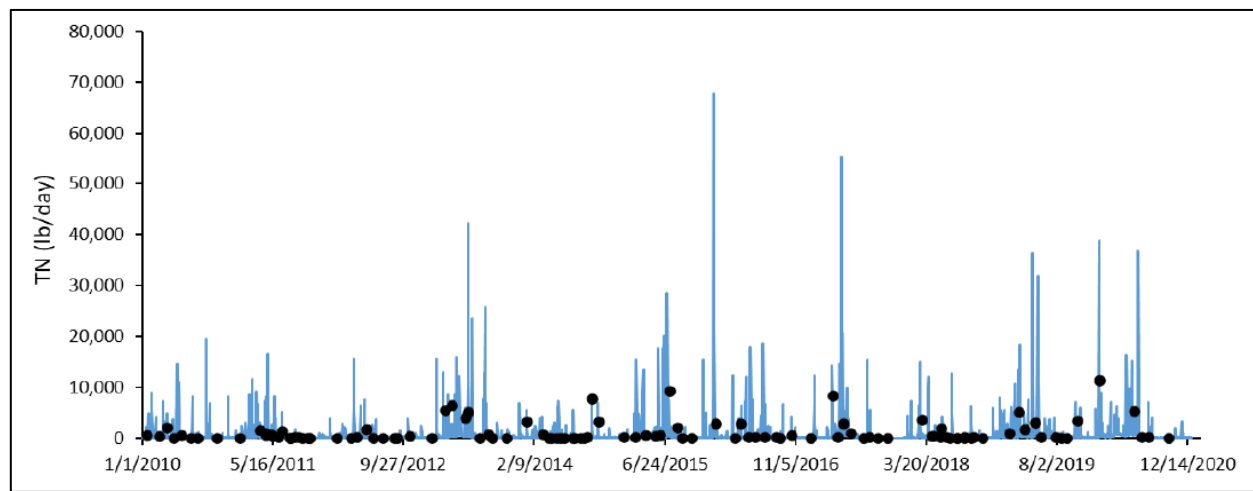


Figure B7. TN regression derived flow-weighted loads for 2010 – 2020

To calculate a flow weighted TP concentration, a regression was developed comparing TP concentration to total suspended solids (TSS) data, shown in Figure B8. The TSS regression derived TP values were then compared to percent flow exceedance to develop a second regression, shown in Figure B9, that was used to calculate the annual average flow-weighted TP value for 2010 – 2020 (Figure B10).

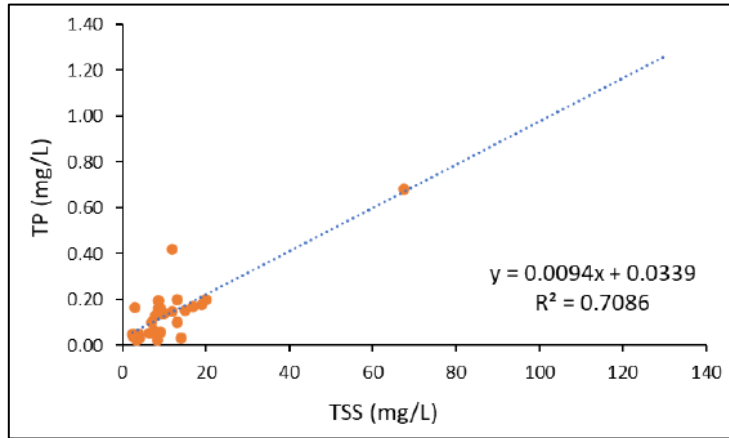


Figure B8. TP and TSS comparison

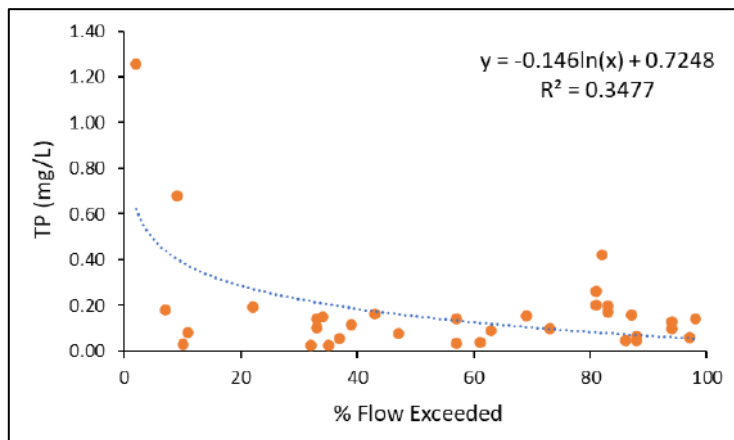


Figure B9. TP flow exceedance comparison

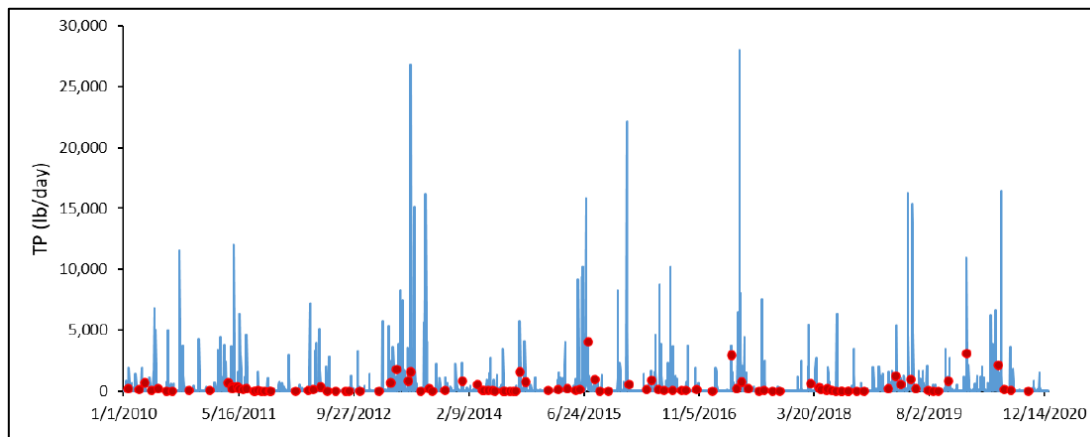


Figure B10. TP regression derived flow-weighted loads for 2010 – 2020

BATHTUB Model Setup

A lake eutrophication model for Pomme de Terre Lake was set up in BATHTUB Version 6.14 so that predicted lake water quality could be calibrated against observed data. The lake was modeled as three separate segments with segment one representing the area near the dam, segment two representing the west arm, and segment three representing the east arm. Segments two and three both flow into segment one, which flows out of the reservoir. Pomme de Terre lake segments are presented in Figure B11.

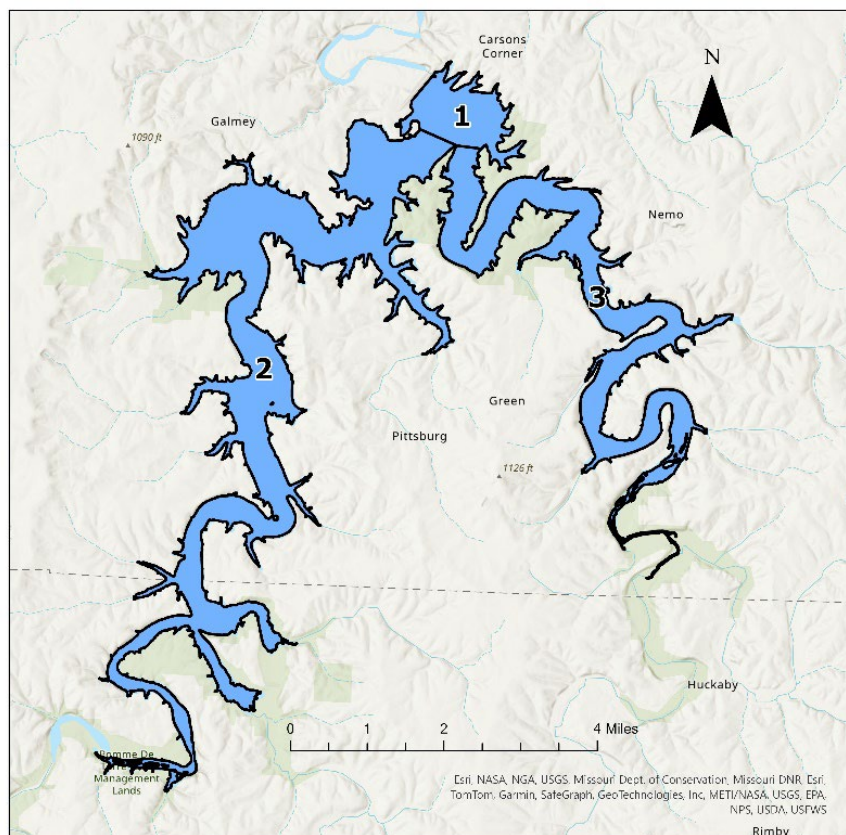


Figure B11. Pomme de Terre Lake BATHTUB segments

Surface area and segment length were calculated in ArcPro. Average depth for each segment was estimated based on bathymetric data and a normal pool level at 840 feet elevation. Segment morphometry is presented in Table B5, the USGS bathymetric map for Pomme de Terre Lake is shown in Figure B12, and additional BATHTUB input variables are included in Table B6.

Table B5 BATHTUB segment morphometry

		Outflow		Area	Depth	Length	Mixed Depth (m)
<u>Seg</u>	<u>Name</u>	<u>Segment</u>	<u>Group</u>	<u>km²</u>	<u>m</u>	<u>km</u>	<u>Mean</u>
1	Near dam	0	1	2.46	13.21	1.5	7.5
2	West Arm	1	1	19.1	8.81	14.88	6.4
3	East Arm	1	1	9.49	7.86	9.95	6

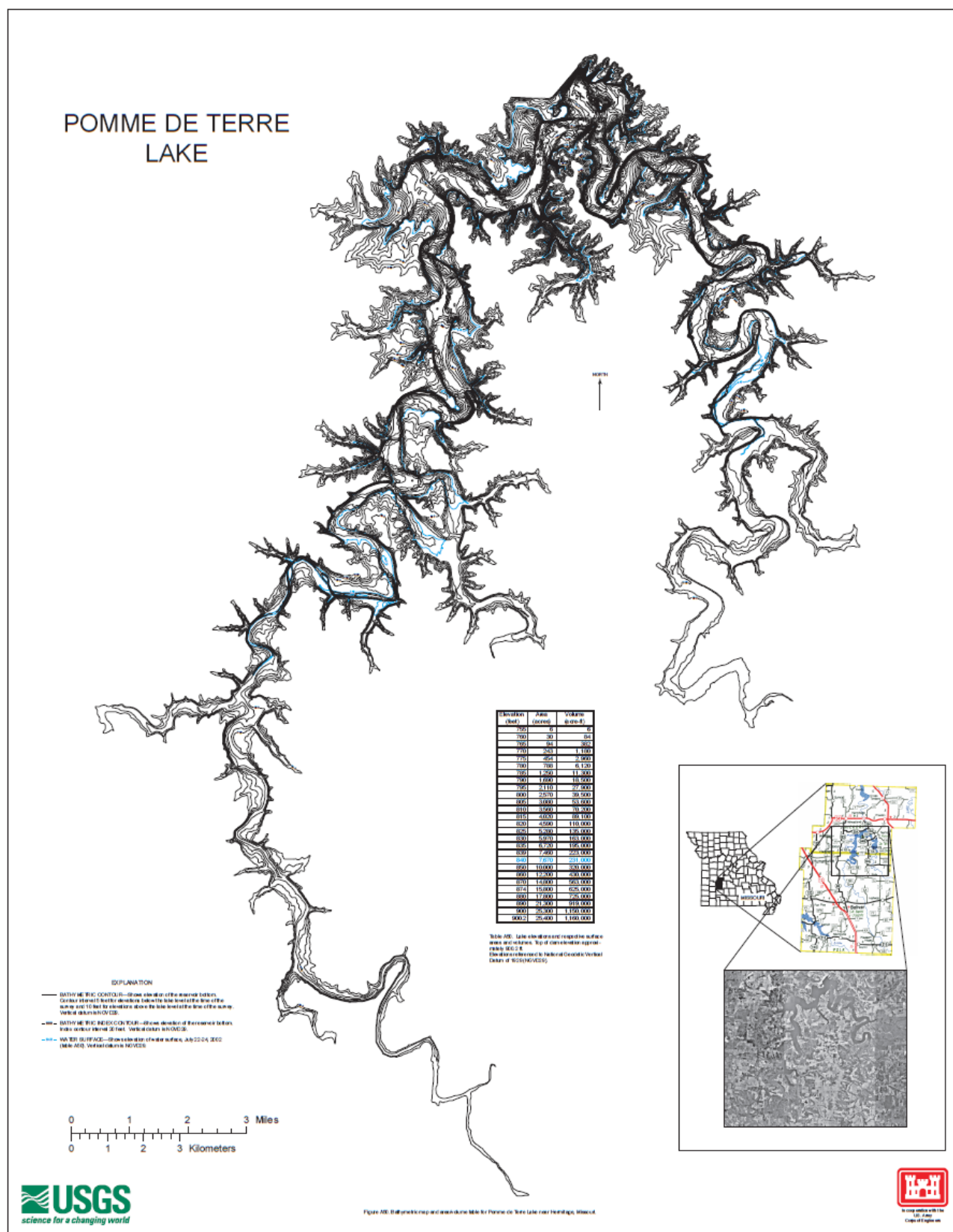


Figure B12. Pomme de Terre Lake bathymetry

Available online at pubs.usgs.gov/of/2013/1101/downloads/A50pomme_final.pdf

Tributary inputs, shown in Table B6, were derived from the calibrated SWAT model outputs for flow, TN, and TP. Daily SWAT outputs from the relevant HUC14 subbasin were downloaded from HAWQS and used to calculate average annual flow volume and average annual inflow concentrations for TN and TP into each lake segment. These inputs contain modeled nutrient loads for both point and nonpoint sources within the watershed.

Table B6. Summary of BATHTUB Model Tributary Inputs

Tributaries	Annual Flow hm³/yr	TP ug/L	TN ug/L
Near Dam	5.6	137.1	768.2
West Arm	432.5	170.5	839.5
East Arm	222.4	149.0	733.3
Outfall	581.0	45.2	626.5

BATHTUB Model Calibration

The BATHTUB model was calibrated to average observed TN and TP concentrations for each lake segment based on all available water quality data from the 2010 – 2020 time period. Calibration was primarily achieved by adjusting model coefficients, presented in Table B7. The segment calibration factor in Segment 1 for Secchi depth was adjusted to 1.5, otherwise all default segment calibration factors were retained.

Table B7. BATHTUB Calibrated Model Coefficients

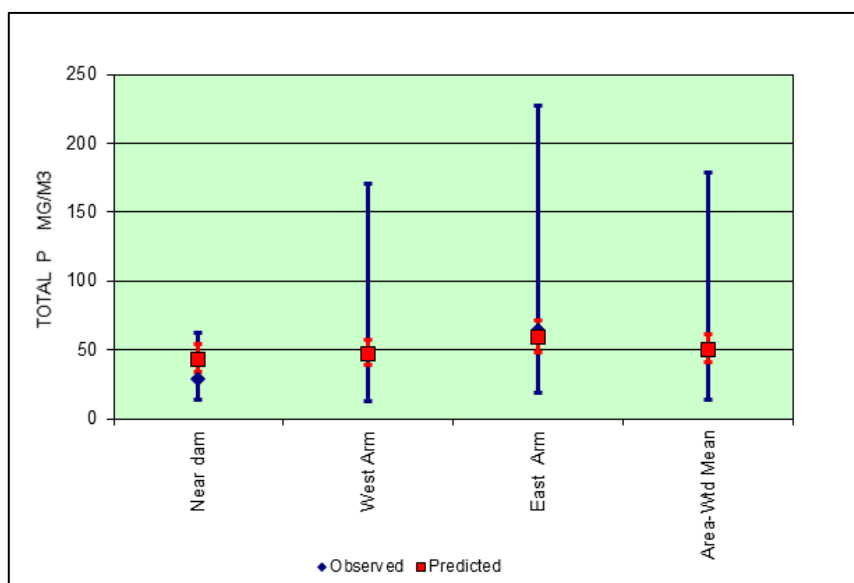
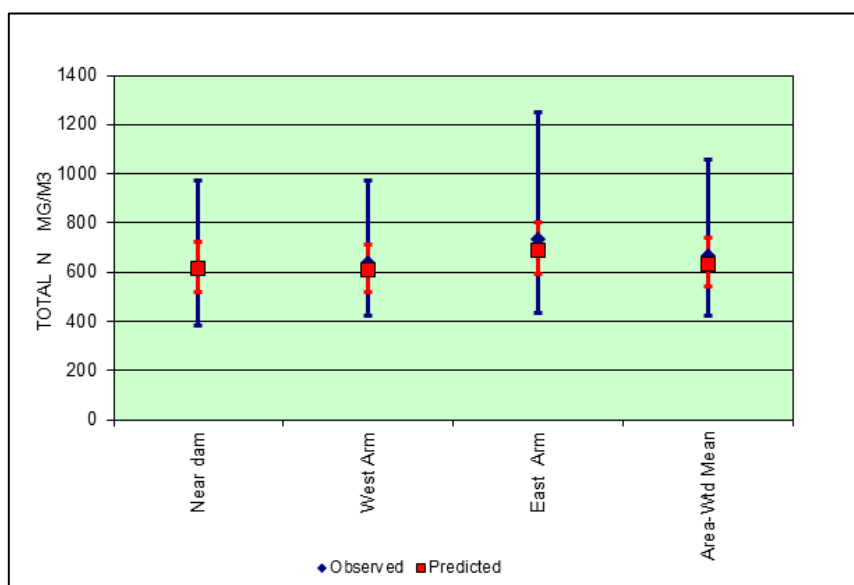
<u>Model Coefficients</u>	<u>Mean</u>	<u>CV</u>
Dispersion Rate	1.000	0.70
Total Phosphorus	2.000	0.45
Total Nitrogen	0.500	0.55
Chl-a Model	1.900	0.26
Secchi Model	0.950	0.10
Organic N Model	1.000	0.12
TP-OP Model	0.950	0.15
HODv Model	1.000	0.15
MODv Model	1.000	0.22
Secchi/Chla Slope (m ² /mg)	0.025	0.00
Minimum Qs (m/yr)	0.100	0.00
Chl-a Flushing Term	1.000	0.00
Chl-a Temporal CV	0.620	0.00

Erosion of bedrock, streambanks, and surface soil within the watershed contributes sediment to Pomme de Terre Lake. Internal loading occurs when phosphorus and nitrogen bound to lake sediment is released into the lake water. Internal load values, presented in Table B8, were also allocated to the east and west lake segments to improve segment specific calibration for TN and TP. Internal loading calculations considered duration of stratification, area of stratification, observed sediment data and available literature data.

Table B8. BATHTUB Model Segment Internal Loads

Internal Loads (mg/m ² -day)			
		TP	TN
Segment	Name	Mean	Mean
1	Near dam	2.59	1.25
2	West Arm	2.42	2.1
3	East Arm	4.19	5.74

Figures B12 – B14 illustrate the final calibrated BATHTUB outputs compared against average TN, TP, Chl-a, and Secchi depth data for each lake segment collected during 2010 – 2020. Additional calibration details are included in Appendix C, Tables C4 and C5.

**Figure B12. Pomme de Terre Lake BATHTUB TP Calibration****Figure B13. Pomme de Terre Lake BATHTUB TN Calibration**

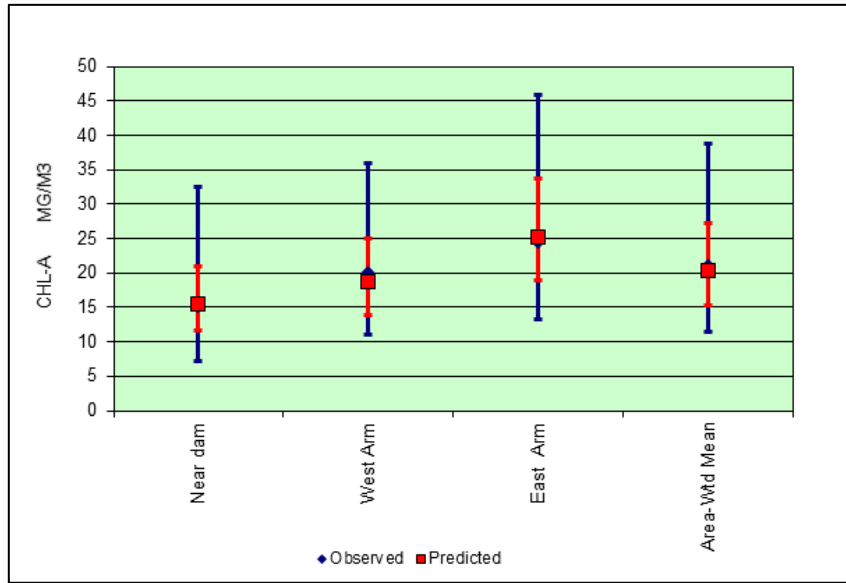


Figure B14. Pomme de Terre Lake BATHTUB chlorophyll-a calibration

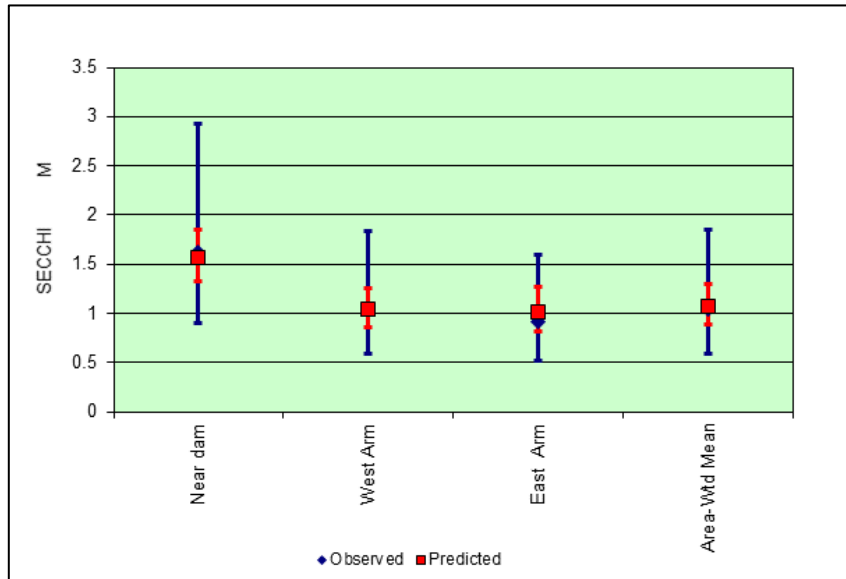


Figure B15. Pomme de Terre Lake BATHTUB Secchi depth Calibration

TMDL BATHTUB Model (2012 Critical Conditions)

After calibration, the BATHTUB model was rerun with tributary flow inputs based on low flow critical conditions to determine the final TMDL loading values. The year 2012 had the lowest measured annual precipitation in the Pomme de Terre Lake Watershed for the date range of 1991 through 2020. Monthly precipitation data are included in Appendix D for both the Pomme de Terre Dam and the greater Springfield area for 1991 - 2020. The tributary flow values in the TMDL BATHTUB model were based on the average annual flow output from the calibrated SWAT model for the year 2012. The tributary inputs and segment internal loads for TN and TP were then adjusted downward, as shown in Tables B9 and B10, until the model predicted attainment of nutrient

screening thresholds in all three lake segments (Table B11). All other model inputs were retained from the calibration model. Detailed model outputs are included in Appendix C in Tables C6 and C7.

Table B9. Summary of critical condition BATHTUB model tributary inputs

Tributaries	Annual Flow (hm³/yr)	TP (µg/L)	TN (µg/L)
Near Dam	3.74	15	400
West Arm	227.81	15	400
East Arm	135.55	10	333
Outfall	367.00	15	400

Table B9. TMDL BATHTUB model segment internal loads

Internal Loads (mg/m²-day)			
		TP	TN
Segment	Name	Mean	Mean
1	Near dam	0.15	0.40
2	West Arm	0.15	0.40
3	East Arm	0.15	0.40

Table B11. Nutrient screening thresholds and respective modeled critical condition values

	TP (µg/L)	TN (µg/L)	Chlorophyll-a (µg/L)
Nutrient Screening Thresholds	16	401	6
Near Dam	9.7	354.5	4.2
West Arm	9.8	355.7	4.7
East Arm	10.7	363.2	5.8
Area-Wtd Mean	10.1	357.9	5.0

Appendix C

Model Input and Outputs

Table C1. SWAT Calibration model HRU characteristics

HRU	SWAT ID	Soil	Area km ²	Slope	Fraction	Land Use	Slope Length	CN2
102901070101012534316PAST0	10001	2534316	6.31	0.04	0.23	PAST	91	84
102901070101012536180PAST0	10002	2536180	10.44	0.05	0.37	PAST	91	84
102901070101012534288PAST0	10003	2534288	3.42	0.05	0.12	PAST	61	69
102901070101012534450PAST0	10004	2534450	2.33	0.06	0.08	PAST	61	79
102901070101012536180FRSD0	10005	2536180	1.64	0.06	0.06	FRSD	61	66
102901070101012535918FRSD0	10006	2535918	3.71	0.11	0.13	FRSD	61	66
10290107010101377988RIWN0	10007	377988	0.03	0.00	0.00	RIWN	122	79
10290107010101377988UPWN0	10008	377988	0.03	0.00	0.00	UPWN	122	79
10290107010101377988RIWF0	10009	377988	0.03	0.00	0.00	RIWF	122	77
102901070101022534316PAST0	20001	2534316	8.91	0.05	0.40	PAST	91	84
102901070101022534288PAST0	20002	2534288	7.85	0.07	0.35	PAST	61	69
102901070101022534158FRSD0	20003	2534158	5.28	0.15	0.24	FRSD	24	66
10290107010102377988UPWN0	20004	377988	0.01	0.00	0.00	UPWN	122	79
10290107010102377988RIWF0	20005	377988	0.02	0.00	0.00	RIWF	122	77
10290107010102377988RIWN0	20006	377988	0.04	0.00	0.00	RIWN	122	79
102901070101032534158FRSD0	30001	2534158	5.67	0.14	0.17	FRSD	24	66
102901070101032533863FRSD0	30002	2533863	2.99	0.07	0.09	FRSD	61	66
102901070101032533863PAST0	30003	2533863	6.82	0.06	0.20	PAST	61	79
102901070101032534734PAST0	30004	2534734	2.88	0.03	0.09	PAST	91	84
102901070101032534316PAST0	30005	2534316	6.73	0.05	0.20	PAST	91	84
102901070101032534288PAST0	30006	2534288	5.68	0.07	0.17	PAST	61	69
102901070101032536180PAST0	30007	2536180	2.63	0.06	0.08	PAST	61	84
10290107010103377988RIWN0	30008	377988	0.04	0.00	0.00	RIWN	122	79
10290107010103377988UPWN0	30009	377988	0.02	0.00	0.00	UPWN	122	79
10290107010103377988RIWF0	30010	377988	0.03	0.00	0.00	RIWF	122	77
102901070101042533918FRSD0	40001	2533918	8.25	0.16	0.99	FRSD	24	66
10290107010104377988RIWN0	40002	377988	0.01	0.00	0.00	RIWN	122	79
10290107010104377988RIWF0	40003	377988	0.04	0.00	0.00	RIWF	122	77
102901070101052533918PAST0	50001	2533918	4.64	0.11	0.17	PAST	61	79
102901070101052533918FRSD0	50002	2533918	6.70	0.17	0.24	FRSD	18	66
102901070101052534158FRSD0	50003	2534158	11.63	0.18	0.42	FRSD	18	66
102901070101052534215FRSD0	50004	2534215	4.69	0.14	0.17	FRSD	24	66
10290107010105377988RIWF0	50005	377988	0.03	0.00	0.00	RIWF	122	77
10290107010105377988WATR0	50006	377988	0.02	0.00	0.00	WATR	122	92
10290107010105377988RIWN0	50007	377988	0.02	0.00	0.00	RIWN	122	79
10290107010105377988UPWN0	50008	377988	0.04	0.00	0.00	UPWN	122	79
10290107010201377988RIWF0	60001	377988	0.04	0.00	0.00	RIWF	122	77
102901070102012534286PAST0	60002	2534286	9.64	0.05	0.48	PAST	61	69
102901070102012534308PAST0	60003	2534308	10.22	0.04	0.51	PAST	91	69
10290107010201377988UPWN0	60004	377988	0.03	0.00	0.00	UPWN	122	79
10290107010201377988RIWN0	60005	377988	0.05	0.00	0.00	RIWN	122	79
102901070102022534081PAST0	70001	2534081	7.94	0.03	0.57	PAST	91	69
102901070102022534318PAST0	70002	2534318	6.05	0.04	0.43	PAST	91	84
10290107010202377988UPWN0	70003	377988	0.02	0.00	0.00	UPWN	122	79
10290107010202377988RIWN0	70004	377988	0.03	0.00	0.00	RIWN	122	79
102901070102031011986PAST0	80001	1011986	2.51	0.06	0.15	PAST	61	79
102901070102032533918PAST0	80002	2533918	3.87	0.07	0.23	PAST	61	79
102901070102032534318PAST0	80003	2534318	3.27	0.04	0.19	PAST	91	84
102901070102032533868FRSD0	80004	2533868	3.62	0.13	0.21	FRSD	24	66
102901070102032533918FRSD0	80005	2533918	3.72	0.10	0.22	FRSD	61	66
10290107010203377988RIWF0	80006	377988	0.05	0.00	0.00	RIWF	122	77
102901070102042533868FRSD0	90001	2533868	5.12	0.14	0.18	FRSD	24	66
102901070102042533918FRSD0	90002	2533918	6.25	0.12	0.22	FRSD	24	66
102901070102041011986PAST0	90003	1011986	2.79	0.06	0.10	PAST	61	79
102901070102042533918PAST0	90004	2533918	3.22	0.07	0.11	PAST	61	79
102901070102042534318PAST0	90005	2534318	3.17	0.05	0.11	PAST	91	84
102901070102042673074PAST0	90006	2673074	3.31	0.05	0.12	PAST	61	69
102901070102042534081PAST0	90007	2534081	4.33	0.04	0.15	PAST	91	69
10290107010204377988UPWN0	90008	377988	0.04	0.00	0.00	UPWN	122	79
102901070103012535849PAST0	100001	2535849	2.34	0.07	0.09	PAST	61	79
102901070103012534321PAST0	100002	2534321	10.23	0.04	0.37	PAST	91	84

HRU	SWAT ID	Soil	Area km ²	Slope	Fraction	Land Use	Slope Length	CN2
102901070103012534387PAST0	100003	2534387	11.00	0.04	0.40	PAST	91	84
102901070103012534286PAST0	100004	2534286	3.35	0.06	0.12	PAST	61	69
10290107010301377988WATR0	100005	377988	0.02	0.00	0.00	WATR	122	92
10290107010301377988RIWN0	100006	377988	0.07	0.00	0.00	RIWN	122	79
10290107010301377988UPWN0	100007	377988	0.05	0.00	0.00	UPWN	122	79
10290107010301377988RIWF0	100008	377988	0.21	0.00	0.01	RIWF	122	77
10290107010301377988UPWF0	100009	377988	0.05	0.00	0.00	UPWF	122	77
102901070103022535849PAST0	110001	2535849	4.26	0.07	0.14	PAST	61	79
102901070103022534321PAST0	110002	2534321	4.58	0.05	0.15	PAST	61	84
102901070103022535878PAST0	110003	2535878	5.55	0.09	0.19	PAST	61	79
102901070103022534387PAST0	110004	2534387	3.53	0.06	0.12	PAST	61	84
102901070103022533918PAST0	110005	2533918	3.84	0.09	0.13	PAST	61	79
10290107010302377988WATR0	110006	377988	0.01	0.00	0.00	WATR	122	92
102901070103022535878FRSD0	110007	2535878	7.74	0.10	0.26	FRSD	61	66
10290107010302377988RIWN0	110008	377988	0.07	0.00	0.00	RIWN	122	79
10290107010302377988UPWF0	110009	377988	0.02	0.00	0.00	UPWF	122	77
10290107010302377988RIWF0	110010	377988	0.17	0.00	0.01	RIWF	122	77
10290107010302377988UPWN0	110011	377988	0.07	0.00	0.00	UPWN	122	79
102901070103032535878FRSD0	120001	2535878	3.73	0.10	0.14	FRSD	61	66
102901070103032534450FRSD0	120002	2534450	3.46	0.08	0.13	FRSD	61	66
102901070103032534200FRSD0	120003	2534200	4.34	0.12	0.16	FRSD	61	66
102901070103032534734PAST0	120004	2534734	3.48	0.03	0.13	PAST	91	84
102901070103032534316PAST0	120005	2534316	4.61	0.06	0.17	PAST	61	84
102901070103032535875PAST0	120006	2535875	3.41	0.08	0.12	PAST	61	79
102901070103032536180PAST0	120007	2536180	4.23	0.05	0.15	PAST	61	84
10290107010303377988WATR0	120008	377988	0.01	0.00	0.00	WATR	122	92
10290107010303377988UPWN0	120009	377988	0.03	0.00	0.00	UPWN	122	79
10290107010303377988RIWN0	120010	377988	0.02	0.00	0.00	RIWN	122	79
10290107010303377988RIWF0	120011	377988	0.02	0.00	0.00	RIWF	122	77
102901070103042534318PAST0	130001	2534318	2.92	0.06	0.11	PAST	61	84
102901070103042533918PAST0	130002	2533918	5.58	0.09	0.21	PAST	61	79
102901070103042534327PAST0	130003	2534327	2.11	0.08	0.08	PAST	61	79
102901070103042534734PAST0	130004	2534734	5.08	0.03	0.19	PAST	91	84
102901070103042533858PAST0	130005	2533858	2.04	0.07	0.08	PAST	61	79
102901070103042534200FRSD0	130006	2534200	6.51	0.09	0.24	FRSD	61	66
102901070103042535918FRSD0	130007	2535918	2.41	0.06	0.09	FRSD	61	66
10290107010304377988RIWF0	130008	377988	0.06	0.00	0.00	RIWF	122	77
10290107010304377988RIWN0	130009	377988	0.03	0.00	0.00	RIWN	122	79
10290107010304377988UPWN0	130010	377988	0.02	0.00	0.00	UPWN	122	79
102901070103052533918PAST0	140001	2533918	6.44	0.09	0.27	PAST	61	79
102901070103052534318PAST0	140002	2534318	3.64	0.06	0.15	PAST	61	84
102901070103052536180PAST0	140003	2536180	3.20	0.04	0.14	PAST	91	84
10290107010305377988WATR0	140004	377988	0.01	0.00	0.00	WATR	122	92
102901070103052534200FRSD0	140005	2534200	2.46	0.11	0.10	FRSD	61	66
102901070103052533918FRSD0	140006	2533918	3.80	0.13	0.16	FRSD	24	66
102901070103052535918FRSD0	140007	2535918	3.83	0.10	0.16	FRSD	61	66
10290107010305377988RIWF0	140008	377988	0.08	0.00	0.00	RIWF	122	77
10290107010305377988RIWN0	140009	377988	0.06	0.00	0.00	RIWN	122	79
10290107010305377988UPWN0	140010	377988	0.03	0.00	0.00	UPWN	122	79
102901070104012532273PAST0	150001	2532273	5.02	0.05	0.98	PAST	61	84
10290107010401377988WATR0	150002	377988	0.02	0.00	0.00	WATR	122	92
10290107010401377988RIWF0	150003	377988	0.07	0.00	0.01	RIWF	122	77
102901070104022534315PAST0	160001	2534315	6.69	0.05	0.22	PAST	91	84
102901070104022534286PAST0	160002	2534286	3.25	0.05	0.11	PAST	91	69
102901070104022533900PAST0	160003	2533900	2.78	0.07	0.09	PAST	61	79
102901070104022535858PAST0	160004	2535858	5.25	0.06	0.17	PAST	61	79
102901070104022533846PAST0	160005	2533846	2.69	0.07	0.09	PAST	61	79
10290107010402889731PAST0	160006	889731	2.69	0.04	0.09	PAST	91	79
102901070104022533950PAST0	160007	2533950	4.19	0.05	0.14	PAST	91	79
102901070104022533915PAST0	160008	2533915	2.57	0.07	0.09	PAST	61	79
10290107010402377988RIWF0	160009	377988	0.05	0.00	0.00	RIWF	122	77
10290107010402377988WATR0	160010	377988	0.03	0.00	0.00	WATR	122	92
10290107010402377988UPWN0	160011	377988	0.03	0.00	0.00	UPWN	122	79
102901070104032535858PAST0	170001	2535858	8.63	0.06	0.45	PAST	61	79
102901070104032534315PAST0	170002	2534315	10.68	0.04	0.55	PAST	91	84
10290107010403377988WATR0	170003	377988	0.03	0.00	0.00	WATR	122	92
10290107010403377988RIWF0	170004	377988	0.02	0.00	0.00	RIWF	122	77

HRU	SWAT ID	Soil	Area km ²	Slope	Fraction	Land Use	Slope Length	CN2
10290107010403377988UPWN0	170005	377988	0.02	0.00	0.00	UPWN	122	79
102901070104042534315PAST0	180001	2534315	8.08	0.04	0.66	PAST	91	84
102901070104042534286PAST0	180002	2534286	4.00	0.06	0.33	PAST	61	69
10290107010404377988WATR0	180003	377988	0.03	0.00	0.00	WATR	122	92
10290107010404377988UPWN0	180004	377988	0.02	0.00	0.00	UPWN	122	79
10290107010404377988RIWF0	180005	377988	0.12	0.00	0.01	RIWF	122	77
10290107010404377988UPWF0	180006	377988	0.01	0.00	0.00	UPWF	122	77
102901070104052534315PAST0	190001	2534315	14.29	0.04	0.62	PAST	91	84
102901070104052534383PAST0	190002	2534383	4.54	0.05	0.20	PAST	61	84
102901070104052534315FRSD0	190003	2534315	4.04	0.05	0.18	FRSD	91	66
10290107010405377988RIWN0	190004	377988	0.05	0.00	0.00	RIWN	122	79
10290107010405377988UPWN0	190005	377988	0.02	0.00	0.00	UPWN	122	79
10290107010405377988RIWF0	190006	377988	0.02	0.00	0.00	RIWF	122	77
102901070104062534321PAST0	200001	2534321	9.79	0.04	0.43	PAST	91	84
10290107010406942121PAST0	200002	942121	7.45	0.05	0.33	PAST	91	79
102901070104062534387PAST0	200003	2534387	5.66	0.06	0.25	PAST	61	84
10290107010406377988UPWN0	200004	377988	0.01	0.00	0.00	UPWN	122	79
10290107010406377988RIWN0	200005	377988	0.02	0.00	0.00	RIWN	122	79
102901070104072535858PAST0	210001	2535858	8.45	0.07	0.65	PAST	61	79
102901070104072534286PAST0	210002	2534286	4.31	0.06	0.33	PAST	61	69
10290107010407377988RIWF0	210003	377988	0.06	0.00	0.00	RIWF	122	77
10290107010407377988WATR0	210004	377988	0.01	0.00	0.00	WATR	122	92
10290107010407377988UPWN0	210005	377988	0.04	0.00	0.00	UPWN	122	79
10290107010407377988UPWF0	210006	377988	0.02	0.00	0.00	UPWF	122	77
10290107010407377988RIWN0	210007	377988	0.02	0.00	0.00	RIWN	122	79
102901070201012535849PAST0	220001	2535849	2.06	0.06	0.08	PAST	61	79
102901070201012534038PAST0	220002	2534038	4.75	0.03	0.18	PAST	91	79
102901070201012534321PAST0	220003	2534321	3.00	0.04	0.12	PAST	91	84
102901070201012673061PAST0	220004	2673061	4.59	0.04	0.18	PAST	91	69
102901070201012533938PAST0	220005	2533938	6.57	0.03	0.25	PAST	91	79
10290107020101954501PAST0	220006	954501	1.96	0.04	0.08	PAST	91	69
102901070201012534306PAST0	220007	2534306	2.78	0.03	0.11	PAST	91	69
10290107020101377988RIWF0	220008	377988	0.03	0.00	0.00	RIWF	122	77
10290107020101377988RIWN0	220009	377988	0.04	0.00	0.00	RIWN	122	79
10290107020101377988UPWN0	220010	377988	0.02	0.00	0.00	UPWN	122	79
102901070201022533945PAST0	230001	2533945	6.44	0.04	1.00	PAST	91	79
102901070201032673061PAST0	240001	2673061	3.14	0.04	0.10	PAST	91	69
102901070201032534038PAST0	240002	2534038	2.79	0.03	0.09	PAST	91	79
10290107020103954501PAST0	240003	954501	4.57	0.04	0.15	PAST	91	69
102901070201032533938PAST0	240004	2533938	5.24	0.04	0.17	PAST	91	79
102901070201032673060PAST0	240005	2673060	2.87	0.03	0.09	PAST	91	79
102901070201032532498PAST0	240006	2532498	1.78	0.03	0.06	PAST	91	79
10290107020103942121PAST0	240007	942121	4.95	0.04	0.16	PAST	91	79
102901070201032536190PAST0	240008	2536190	5.41	0.03	0.18	PAST	91	84
10290107020103377988WATR0	240009	377988	0.02	0.00	0.00	WATR	122	92
10290107020103377988RIWF0	240010	377988	0.03	0.00	0.00	RIWF	122	77
10290107020103377988RIWN0	240011	377988	0.06	0.00	0.00	RIWN	122	79
10290107020103377988UPWN0	240012	377988	0.03	0.00	0.00	UPWN	122	79
102901070202012534330FRSD0	250001	2534330	1.74	0.06	0.06	FRSD	61	77
102901070202012535849FRSD0	250002	2535849	2.27	0.07	0.08	FRSD	61	77
102901070202012534378PAST0	250003	2534378	2.38	0.03	0.09	PAST	91	84
102901070202012534038PAST0	250004	2534038	1.86	0.03	0.07	PAST	91	79
102901070202012533938PAST0	250005	2533938	8.38	0.03	0.30	PAST	91	79
10290107020201954501PAST0	250006	954501	7.93	0.04	0.28	PAST	91	69
102901070202012535849PAST0	250007	2535849	3.25	0.05	0.12	PAST	61	79
10290107020201377988WATR0	250008	377988	0.01	0.00	0.00	WATR	122	92
10290107020201377988UPWN0	250009	377988	0.02	0.00	0.00	UPWN	122	79
10290107020201377988RIWN0	250010	377988	0.02	0.00	0.00	RIWN	122	79
102901070202022534321PAST0	260001	2534321	4.25	0.04	0.21	PAST	91	84
102901070202022535849PAST0	260002	2535849	5.26	0.06	0.26	PAST	61	79
102901070202022535849FRSD0	260003	2535849	3.62	0.07	0.18	FRSD	61	77
102901070202022534321FRSD0	260004	2534321	2.67	0.06	0.13	FRSD	61	77
102901070202022535878FRSD0	260005	2535878	4.65	0.09	0.23	FRSD	61	77
10290107020202377988RIWN0	260006	377988	0.05	0.00	0.00	RIWN	122	79
10290107020202377988UPWN0	260007	377988	0.03	0.00	0.00	UPWN	122	79
10290107020202377988RIWF0	260008	377988	0.02	0.00	0.00	RIWF	122	77
102901070202032534387PAST0	270001	2534387	3.10	0.05	0.18	PAST	61	84

HRU	SWAT ID	Soil	Area km ²	Slope	Fraction	Land Use	Slope Length	CN2
102901070202032535849PAST0	270002	2535849	4.24	0.06	0.24	PAST	61	79
102901070202032534321PAST0	270003	2534321	4.17	0.04	0.24	PAST	91	84
10290107020203377988WATR0	270004	377988	0.02	0.00	0.00	WATR	122	92
102901070202032535849FRSD0	270005	2535849	3.23	0.07	0.18	FRSD	61	77
102901070202032535878FRSD0	270006	2535878	2.86	0.08	0.16	FRSD	61	77
10290107020203377988UPWN0	270007	377988	0.02	0.00	0.00	UPWN	122	79
10290107020203377988RIWN0	270008	377988	0.01	0.00	0.00	RIWN	122	79
10290107020203377988UPWF0	270009	377988	0.01	0.00	0.00	UPWF	122	77
10290107020203377988RIWF0	270010	377988	0.04	0.00	0.00	RIWF	122	77
102901070202042534453PAST0	280001	2534453	6.67	0.06	0.99	PAST	61	79
10290107020204377988RIWN0	280002	377988	0.08	0.00	0.01	RIWN	122	79
102901070202052535849PAST0	290001	2535849	8.34	0.06	1.00	PAST	61	79
10290107020205377988RIWN0	290002	377988	0.03	0.00	0.00	RIWN	122	79
102901070202062534321FRSD0	300001	2534321	2.40	0.05	0.11	FRSD	91	77
102901070202062534321PAST0	300002	2534321	4.96	0.04	0.22	PAST	91	84
102901070202062534038PAST0	300003	2534038	2.40	0.03	0.11	PAST	91	79
102901070202062534387PAST0	300004	2534387	2.28	0.05	0.10	PAST	91	84
102901070202062535849PAST0	300005	2535849	5.40	0.05	0.24	PAST	61	79
102901070202062533938PAST0	300006	2533938	5.03	0.03	0.22	PAST	91	79
10290107020206377988RIWN0	300007	377988	0.06	0.00	0.00	RIWN	122	79
10290107020206377988UPWN0	300008	377988	0.02	0.00	0.00	UPWN	122	79
10290107020206377988UPWF0	300009	377988	0.01	0.00	0.00	UPWF	122	77
102901070203012534315PAST0	310001	2534315	6.77	0.04	0.37	PAST	91	84
102901070203012534315FRSD0	310002	2534315	4.99	0.05	0.27	FRSD	61	77
102901070203012535858FRSD0	310003	2535858	6.44	0.07	0.35	FRSD	61	77
10290107020301377988UPWN0	310004	377988	0.02	0.00	0.00	UPWN	122	79
10290107020302377988RIWF0	320001	377988	0.09	0.00	0.01	RIWF	122	77
102901070203022535858FRSD0	320002	2535858	2.54	0.08	0.17	FRSD	61	77
102901070203022534448FRSD0	320003	2534448	3.24	0.09	0.22	FRSD	61	77
102901070203022534315PAST0	320004	2534315	6.09	0.05	0.42	PAST	91	84
102901070203022534448PAST0	320005	2534448	2.52	0.07	0.17	PAST	61	79
10290107020302377988UPWN0	320006	377988	0.03	0.00	0.00	UPWN	122	79
10290107020302377988RIWN0	320007	377988	0.05	0.00	0.00	RIWN	122	79
102901070203032534315PAST0	330001	2534315	6.07	0.04	0.30	PAST	91	84
102901070203032535858PAST0	330002	2535858	4.15	0.07	0.21	PAST	61	79
102901070203032534448PAST0	330003	2534448	2.85	0.06	0.14	PAST	61	79
10290107020303377988WATR0	330004	377988	0.01	0.00	0.00	WATR	122	92
102901070203032534315FRSD0	330005	2534315	2.08	0.05	0.10	FRSD	91	77
102901070203032535858FRSD0	330006	2535858	4.63	0.07	0.23	FRSD	61	77
10290107020303377988UPWN0	330007	377988	0.04	0.00	0.00	UPWN	122	79
10290107020303377988RIWN0	330008	377988	0.07	0.00	0.00	RIWN	122	79
10290107020303377988RIWF0	330009	377988	0.03	0.00	0.00	RIWF	122	77
102901070203042535858FRSD0	340001	2535858	4.58	0.08	0.26	FRSD	61	77
102901070203042535858PAST0	340002	2535858	6.23	0.07	0.35	PAST	61	79
102901070203042534448PAST0	340003	2534448	2.66	0.07	0.15	PAST	61	79
102901070203042534315PAST0	340004	2534315	4.16	0.05	0.24	PAST	91	84
10290107020304377988UPWN0	340005	377988	0.02	0.00	0.00	UPWN	122	79
10290107020304377988RIWN0	340006	377988	0.02	0.00	0.00	RIWN	122	79
102901070203052534315PAST0	350001	2534315	3.67	0.04	0.13	PAST	91	84
102901070203052535858PAST0	350002	2535858	8.30	0.05	0.29	PAST	61	79
102901070203052534042PAST0	350003	2534042	2.70	0.03	0.09	PAST	91	79
102901070203052534079PAST0	350004	2534079	1.80	0.04	0.06	PAST	91	69
102901070203052532273PAST0	350005	2532273	2.87	0.04	0.10	PAST	91	84
102901070203052673161PAST0	350006	2673161	1.75	0.03	0.06	PAST	91	69
102901070203052534448PAST0	350007	2534448	3.39	0.05	0.12	PAST	91	79
102901070203052533945PAST0	350008	2533945	4.23	0.03	0.15	PAST	91	79
10290107020305377988RIWF0	350009	377988	0.03	0.00	0.00	RIWF	122	77
10290107020305377988RIWN0	350010	377988	0.03	0.00	0.00	RIWN	122	79
10290107020305377988UPWN0	350011	377988	0.02	0.00	0.00	UPWN	122	79
102901070204012534378FRSD0	360001	2534378	2.43	0.04	0.09	FRSD	91	66
102901070204012533924FRSD0	360002	2533924	4.00	0.08	0.15	FRSD	61	66
102901070204012534321FRSD0	360003	2534321	2.55	0.05	0.10	FRSD	61	66
102901070204012534378PAST0	360004	2534378	3.69	0.03	0.14	PAST	91	84
102901070204012534321PAST0	360005	2534321	2.05	0.04	0.08	PAST	91	84
102901070204012534038PAST0	360006	2534038	2.96	0.02	0.11	PAST	91	79
102901070204012533938PAST0	360007	2533938	3.96	0.03	0.15	PAST	91	79
102901070204012534470PAST0	360008	2534470	5.04	0.02	0.19	PAST	122	84

HRU	SWAT ID	Soil	Area km ²	Slope	Fraction	Land Use	Slope Length	CN2
10290107020401377988UPWN0	360009	377988	0.02	0.00	0.00	UPWN	122	79
10290107020401377988RIWN0	360010	377988	0.01	0.00	0.00	RIWN	122	79
102901070204022534851PAST0	370001	2534851	7.11	0.04	0.36	PAST	91	84
102901070204022534732PAST0	370002	2534732	6.69	0.04	0.34	PAST	91	84
102901070204022536110FRSD0	370003	2536110	5.81	0.08	0.30	FRSD	61	66
10290107020402377988RIWF0	370004	377988	0.02	0.00	0.00	RIWF	122	77
102901070204032535873FRSD0	380001	2535873	3.19	0.14	0.29	FRSD	24	66
102901070204032534448FRSD0	380002	2534448	7.19	0.11	0.66	FRSD	61	66
10290107020403377988RIWF0	380003	377988	0.46	0.00	0.04	RIWF	122	77
10290107020403377988RIWN0	380004	377988	0.01	0.00	0.00	RIWN	122	79
102901070204042534315PAST0	390001	2534315	5.90	0.06	0.28	PAST	61	84
102901070204042534448PAST0	390002	2534448	5.72	0.09	0.27	PAST	61	79
102901070204042536407PAST0	390003	2536407	2.84	0.02	0.13	PAST	91	69
102901070204042534448FRSD0	390004	2534448	6.61	0.11	0.31	FRSD	61	66
10290107020404377988RIWN0	390005	377988	0.09	0.00	0.00	RIWN	122	79
10290107020404377988RIWF0	390006	377988	0.21	0.00	0.01	RIWF	122	77
10290107020404377988UPWN0	390007	377988	0.02	0.00	0.00	UPWN	122	79
102901070204052534448PAST0	400001	2534448	7.56	0.07	0.41	PAST	61	79
102901070204052534315PAST0	400002	2534315	7.37	0.05	0.40	PAST	91	84
102901070204052533882PAST0	400003	2533882	3.41	0.03	0.19	PAST	91	79
10290107020405377988RIWN0	400004	377988	0.02	0.00	0.00	RIWN	122	79
10290107020405377988RIWF0	400005	377988	0.02	0.00	0.00	RIWF	122	77
10290107020405377988WATR0	400006	377988	0.01	0.00	0.00	WATR	122	92
102901070204062534448PAST0	410001	2534448	6.09	0.07	0.20	PAST	61	79
102901070204062534315PAST0	410002	2534315	7.51	0.04	0.24	PAST	91	84
102901070204062533950PAST0	410003	2533950	4.21	0.05	0.14	PAST	61	79
102901070204062534042PAST0	410004	2534042	3.20	0.03	0.10	PAST	91	79
10290107020406889731PAST0	410005	889731	2.57	0.04	0.08	PAST	91	79
102901070204062532283PAST0	410006	2532283	2.59	0.04	0.08	PAST	91	84
102901070204062534448FRSD0	410007	2534448	4.71	0.08	0.15	FRSD	61	66
10290107020406377988UPWN0	410008	377988	0.02	0.00	0.00	UPWN	122	79
10290107020406377988RIWF0	410009	377988	0.01	0.00	0.00	RIWF	122	77
102901070204072535872FRSD0	420001	2535872	3.09	0.10	0.12	FRSD	61	66
102901070204072534448FRSD0	420002	2534448	6.52	0.08	0.26	FRSD	61	66
102901070204072534315FRSD0	420003	2534315	5.44	0.06	0.22	FRSD	61	66
102901070204072534448PAST0	420004	2534448	3.50	0.07	0.14	PAST	61	79
102901070204072534315PAST0	420005	2534315	6.48	0.05	0.26	PAST	61	84
10290107020407377988UPWN0	420006	377988	0.01	0.00	0.00	UPWN	122	79
10290107020407377988RIWF0	420007	377988	0.04	0.00	0.00	RIWF	122	77
10290107020407377988RIWN0	420008	377988	0.04	0.00	0.00	RIWN	122	79
102901070204082535858FRSD0	430001	2535858	4.08	0.08	0.55	FRSD	61	66
102901070204082535858PAST0	430002	2535858	3.31	0.07	0.45	PAST	61	79
10290107020501377988WATR0	440001	377988	0.47	0.00	0.03	WATR	122	92
102901070205012536142FRSD0	440002	2536142	5.74	0.15	0.35	FRSD	24	66
102901070205012536110FRSD0	440003	2536110	10.18	0.10	0.62	FRSD	61	66
102901070205022534851PAST0	450001	2534851	2.36	0.03	0.12	PAST	91	84
10290107020502377988WATR0	450002	377988	0.25	0.00	0.01	WATR	122	92
102901070205022536103FRSD0	450003	2536103	2.92	0.10	0.15	FRSD	61	66
102901070205022536110FRSD0	450004	2536110	12.00	0.13	0.60	FRSD	24	66
102901070205022536142FRSD0	450005	2536142	2.52	0.15	0.13	FRSD	24	66
102901070205032536110FRSD0	460001	2536110	16.22	0.12	0.58	FRSD	24	66
102901070205032536142FRSD0	460002	2536142	4.41	0.16	0.16	FRSD	18	66
102901070205032534851FRSD0	460003	2534851	2.53	0.07	0.09	FRSD	61	66
102901070205032536103FRSD0	460004	2536103	3.69	0.10	0.13	FRSD	61	66
10290107020503377988WATR0	460005	377988	0.58	0.00	0.02	WATR	122	92
10290107020503377988RIWF0	460006	377988	0.33	0.00	0.01	RIWF	122	77
102901070301012534315FRSD0	470001	2534315	2.32	0.06	0.07	FRSD	61	66
102901070301012534448FRSD0	470002	2534448	2.74	0.08	0.09	FRSD	61	66
102901070301012535858FRSD0	470003	2535858	2.00	0.09	0.06	FRSD	61	66
102901070301012532279FRSD0	470004	2532279	1.89	0.07	0.06	FRSD	61	66
102901070301012534315PAST0	470005	2534315	8.38	0.05	0.27	PAST	61	84
102901070301012534448PAST0	470006	2534448	5.11	0.07	0.16	PAST	61	79
102901070301012532279PAST0	470007	2532279	3.53	0.07	0.11	PAST	61	79
102901070301012534286PAST0	470008	2534286	2.41	0.05	0.08	PAST	61	69
102901070301012535858PAST0	470009	2535858	2.74	0.07	0.09	PAST	61	79
10290107030101377988UPWN0	470010	377988	0.01	0.00	0.00	UPWN	122	79
10290107030102377988WATR0	480001	377988	0.06	0.00	0.00	WATR	122	92

HRU	SWAT ID	Soil	Area km ²	Slope	Fraction	Land Use	Slope Length	CN2
102901070301022535858FRSD0	480002	2535858	5.14	0.08	0.18	FRSD	61	66
102901070301022534286PAST0	480003	2534286	3.79	0.05	0.13	PAST	61	69
102901070301022535858PAST0	480004	2535858	6.16	0.08	0.22	PAST	61	79
102901070301022534315PAST0	480005	2534315	5.75	0.05	0.20	PAST	91	84
102901070301022533945PAST0	480006	2533945	4.07	0.04	0.14	PAST	91	79
102901070301022534448PAST0	480007	2534448	3.42	0.07	0.12	PAST	61	79
10290107030102377988RIWN0	480008	377988	0.02	0.00	0.00	RIWN	122	79
10290107030102377988RIWF0	480009	377988	0.05	0.00	0.00	RIWF	122	77
10290107030102377988UPWN0	480010	377988	0.06	0.00	0.00	UPWN	122	79
102901070301032534315PAST0	490001	2534315	10.70	0.05	0.45	PAST	61	84
102901070301032534383PAST0	490002	2534383	2.88	0.06	0.12	PAST	61	84
102901070301032534315FRSD0	490003	2534315	6.24	0.05	0.26	FRSD	61	66
102901070301032533915FRSD0	490004	2533915	4.02	0.07	0.17	FRSD	61	66
10290107030103377988RIWN0	490005	377988	0.02	0.00	0.00	RIWN	122	79
10290107030103377988UPWN0	490006	377988	0.01	0.00	0.00	UPWN	122	79
102901070301042535858PAST0	500001	2535858	6.99	0.08	0.57	PAST	61	79
102901070301042534315PAST0	500002	2534315	5.38	0.06	0.43	PAST	61	84
102901070302012534315PAST0	510001	2534315	9.36	0.05	0.50	PAST	91	84
102901070302012533950PAST0	510002	2533950	4.39	0.06	0.24	PAST	61	79
10290107030201889731PAST0	510003	889731	4.87	0.04	0.26	PAST	91	79
10290107030201377988RIWF0	510004	377988	0.02	0.00	0.00	RIWF	122	77
10290107030201377988RIWN0	510005	377988	0.01	0.00	0.00	RIWN	122	79
102901070302022534315PAST0	520001	2534315	6.20	0.04	0.26	PAST	91	84
102901070302022532279PAST0	520002	2532279	6.08	0.06	0.25	PAST	61	79
102901070302022535858PAST0	520003	2535858	4.29	0.07	0.18	PAST	61	79
102901070302022534448PAST0	520004	2534448	2.57	0.06	0.11	PAST	61	79
102901070302022532279FRSD0	520005	2532279	2.20	0.07	0.09	FRSD	61	77
102901070302022535858FRSD0	520006	2535858	2.74	0.08	0.11	FRSD	61	77
102901070302032532273PAST0	530001	2532273	9.81	0.03	0.61	PAST	91	84
102901070302032533882PAST0	530002	2533882	6.17	0.02	0.39	PAST	91	79
10290107030203377988RIWN0	530003	377988	0.02	0.00	0.00	RIWN	122	79
10290107030203377988RIWF0	530004	377988	0.02	0.00	0.00	RIWF	122	77
102901070302042532273PAST0	540001	2532273	13.79	0.03	0.44	PAST	91	84
102901070302042533950PAST0	540002	2533950	5.12	0.06	0.16	PAST	61	79
102901070302042534315PAST0	540003	2534315	8.42	0.05	0.27	PAST	91	84
102901070302042534315FRSD0	540004	2534315	4.28	0.05	0.13	FRSD	61	77
10290107030204377988WATR0	540005	377988	0.01	0.00	0.00	WATR	122	92
10290107030204377988UPWN0	540006	377988	0.02	0.00	0.00	UPWN	122	79
10290107030204377988UPWF0	540007	377988	0.01	0.00	0.00	UPWF	122	77
10290107030204377988RIWF0	540008	377988	0.03	0.00	0.00	RIWF	122	77
10290107030204377988RIWN0	540009	377988	0.03	0.00	0.00	RIWN	122	79
102901070303012536209PAST0	550001	2536209	5.42	0.03	1.00	PAST	91	84
102901070303022534315PAST0	560001	2534315	7.42	0.04	0.26	PAST	91	84
102901070303022535858PAST0	560002	2535858	5.24	0.07	0.18	PAST	61	79
102901070303022532279PAST0	560003	2532279	4.69	0.06	0.16	PAST	61	79
102901070303022536244PAST0	560004	2536244	2.87	0.05	0.10	PAST	91	79
102901070303022536209PAST0	560005	2536209	3.93	0.03	0.14	PAST	91	84
102901070303022533945PAST0	560006	2533945	4.56	0.03	0.16	PAST	91	79
10290107030302377988WATR0	560007	377988	0.02	0.00	0.00	WATR	122	92
10290107030302377988RIWN0	560008	377988	0.09	0.00	0.00	RIWN	122	79
10290107030302377988RIWF0	560009	377988	0.02	0.00	0.00	RIWF	122	77
102901070303032534315PAST0	570001	2534315	5.62	0.03	0.27	PAST	91	84
102901070303032532279PAST0	570002	2532279	3.85	0.06	0.19	PAST	61	79
102901070303032534315URLD0	570003	2534315	4.37	0.03	0.21	URLD	91	72
102901070303032533882URLD0	570004	2533882	3.41	0.02	0.16	URLD	122	72
102901070303032533945URLD0	570005	2533945	3.42	0.04	0.16	URLD	91	72
10290107030303377988WATR0	570006	377988	0.03	0.00	0.00	WATR	122	92
10290107030303377988RIWF0	570007	377988	0.03	0.00	0.00	RIWF	122	77
10290107030303377988RIWN0	570008	377988	0.04	0.00	0.00	RIWN	122	79
10290107030303377988UPWN0	570009	377988	0.02	0.00	0.00	UPWN	122	79
102901070303042534315PAST0	580001	2534315	10.78	0.04	1.00	PAST	91	84
10290107030304377988RIWN0	580002	377988	0.01	0.00	0.00	RIWN	122	79
10290107030304377988UPWN0	580003	377988	0.01	0.00	0.00	UPWN	122	79
102901070303052534315PAST0	590001	2534315	6.43	0.04	0.21	PAST	91	84
102901070303052533882PAST0	590002	2533882	11.04	0.02	0.36	PAST	91	79
102901070303052532279PAST0	590003	2532279	2.16	0.06	0.07	PAST	61	79
102901070303052534286PAST0	590004	2534286	3.69	0.05	0.12	PAST	61	69

HRU	SWAT ID	Soil	Area km ²	Slope	Fraction	Land Use	Slope Length	CN2
102901070303052533945PAST0	590005	2533945	4.74	0.04	0.16	PAST	91	79
102901070303052534448PAST0	590006	2534448	2.22	0.06	0.07	PAST	61	79
10290107030305377988RIWN0	590007	377988	0.01	0.00	0.00	RIWN	122	79
10290107030305377988UPWN0	590008	377988	0.02	0.00	0.00	UPWN	122	79
102901070304012534315PAST0	600001	2534315	13.12	0.05	0.99	PAST	61	84
10290107030401377988WATR0	600002	377988	0.04	0.00	0.00	WATR	122	92
10290107030401377988RIWN0	600003	377988	0.03	0.00	0.00	RIWN	122	79
10290107030401377988UPWN0	600004	377988	0.01	0.00	0.00	UPWN	122	79
10290107030401377988RIWF0	600005	377988	0.01	0.00	0.00	RIWF	122	77
102901070304022534227FRSD0	610001	2534227	3.83	0.14	0.13	FRSD	24	66
102901070304022534315PAST0	610002	2534315	12.67	0.04	0.44	PAST	91	84
102901070304022534227PAST0	610003	2534227	3.35	0.09	0.12	PAST	61	84
102901070304022534286PAST0	610004	2534286	3.82	0.06	0.13	PAST	61	69
102901070304022534733PAST0	610005	2534733	5.10	0.03	0.18	PAST	91	84
10290107030402377988WATR0	610006	377988	0.06	0.00	0.00	WATR	122	92
10290107030402377988RIWF0	610007	377988	0.03	0.00	0.00	RIWF	122	77
10290107030402377988RIWN0	610008	377988	0.03	0.00	0.00	RIWN	122	79
10290107030402377988UPWN0	610009	377988	0.02	0.00	0.00	UPWN	122	79
102901070304032534315PAST0	620001	2534315	10.48	0.05	0.36	PAST	91	84
102901070304032532279PAST0	620002	2532279	6.92	0.07	0.24	PAST	61	79
102901070304032534286PAST0	620003	2534286	4.18	0.06	0.14	PAST	61	69
102901070304032534448PAST0	620004	2534448	3.79	0.07	0.13	PAST	61	79
102901070304032673159PAST0	620005	2673159	3.43	0.06	0.12	PAST	61	69
10290107030403377988WATR0	620006	377988	0.05	0.00	0.00	WATR	122	92
10290107030403377988RIWF0	620007	377988	0.04	0.00	0.00	RIWF	122	77
102901070305012534315PAST0	630001	2534315	6.84	0.04	0.28	PAST	91	84
102901070305012534448PAST0	630002	2534448	4.34	0.06	0.18	PAST	61	79
102901070305012534286PAST0	630003	2534286	3.06	0.06	0.12	PAST	61	69
102901070305012535858FRSD0	630004	2535858	4.77	0.09	0.19	FRSD	61	66
102901070305012534448FRSD0	630005	2534448	5.61	0.07	0.23	FRSD	61	66
10290107030501377988WATR0	630006	377988	0.01	0.00	0.00	WATR	122	92
10290107030501377988UPWN0	630007	377988	0.03	0.00	0.00	UPWN	122	79
10290107030501377988RIWF0	630008	377988	0.02	0.00	0.00	RIWF	122	77
10290107030501377988RIWN0	630009	377988	0.01	0.00	0.00	RIWN	122	79
102901070305022535858PAST0	640001	2535858	3.84	0.07	0.22	PAST	61	79
102901070305022535858FRSD0	640002	2535858	10.58	0.08	0.59	FRSD	61	66
102901070305022533870FRSD0	640003	2533870	3.40	0.10	0.19	FRSD	61	66
10290107030502377988RIWN0	640004	377988	0.02	0.00	0.00	RIWN	122	79
102901070305032535858FRSD0	650001	2535858	7.14	0.08	0.45	FRSD	61	66
102901070305032534315PAST0	650002	2534315	4.81	0.04	0.30	PAST	91	84
102901070305032535858PAST0	650003	2535858	3.99	0.07	0.25	PAST	61	79
10290107030503377988WATR0	650004	377988	0.05	0.00	0.00	WATR	122	92
10290107030503377988RIWN0	650005	377988	0.02	0.00	0.00	RIWN	122	79
10290107030503377988UPWN0	650006	377988	0.02	0.00	0.00	UPWN	122	79
10290107030503377988RIWF0	650007	377988	0.02	0.00	0.00	RIWF	122	77
102901070305042535858PAST0	660001	2535858	4.46	0.07	0.20	PAST	61	79
102901070305042534315PAST0	660002	2534315	2.45	0.04	0.11	PAST	91	84
102901070305042533871PAST0	660003	2533871	2.67	0.06	0.12	PAST	61	84
102901070305042533950PAST0	660004	2533950	2.83	0.05	0.13	PAST	91	79
102901070305042535858FRSD0	660005	2535858	4.90	0.08	0.22	FRSD	61	66
102901070305042533870FRSD0	660006	2533870	4.54	0.10	0.21	FRSD	61	66
10290107030504377988RIWF0	660007	377988	0.02	0.00	0.00	RIWF	122	77
10290107030504377988UPWN0	660008	377988	0.01	0.00	0.00	UPWN	122	79
10290107030504377988RIWN0	660009	377988	0.01	0.00	0.00	RIWN	122	79
102901070305052534315PAST0	670001	2534315	7.54	0.05	0.28	PAST	61	84
102901070305052535858PAST0	670002	2535858	4.10	0.07	0.15	PAST	61	79
102901070305052536209PAST0	670003	2536209	4.54	0.04	0.17	PAST	91	84
102901070305052533867FRSD0	670004	2533867	4.17	0.11	0.16	FRSD	61	66
102901070305052535858FRSD0	670005	2535858	2.78	0.08	0.10	FRSD	61	66
102901070305052534448FRSD0	670006	2534448	3.25	0.10	0.12	FRSD	61	66
10290107030505377988WATR0	670007	377988	0.06	0.00	0.00	WATR	122	92
10290107030505377988RIWN0	670008	377988	0.03	0.00	0.00	RIWN	122	79
10290107030505377988RIWF0	670009	377988	0.03	0.00	0.00	RIWF	122	77
10290107030505377988UPWN0	670010	377988	0.01	0.00	0.00	UPWN	122	79
102901070305062533870FRSD0	680001	2533870	9.26	0.10	0.52	FRSD	61	66
102901070305062534315PAST0	680002	2534315	8.57	0.04	0.48	PAST	91	84
10290107030506377988RIWF0	680003	377988	0.02	0.00	0.00	RIWF	122	77

HRU	SWAT ID	Soil	Area km ²	Slope	Fraction	Land Use	Slope Length	CN2
10290107030506377988RIWN0	680004	377988	0.01	0.00	0.00	RIWN	122	79
102901070305072532273PAST0	690001	2532273	14.60	0.04	1.00	PAST	91	84
10290107030507377988RIWN0	690002	377988	0.01	0.00	0.00	RIWN	122	79
102901070306012534315PAST0	700001	2534315	3.03	0.05	0.16	PAST	61	84
102901070306012534448PAST0	700002	2534448	3.00	0.08	0.16	PAST	61	79
102901070306012533950PAST0	700003	2533950	6.23	0.06	0.33	PAST	61	79
10290107030601889731PAST0	700004	889731	3.54	0.04	0.19	PAST	91	79
102901070306012534448FRSD0	700005	2534448	2.81	0.09	0.15	FRSD	61	66
10290107030601377988RIWF0	700006	377988	0.02	0.00	0.00	RIWF	122	77
102901070306022534315PAST0	710001	2534315	4.37	0.04	0.26	PAST	91	84
102901070306022534733PAST0	710002	2534733	3.37	0.03	0.20	PAST	91	84
102901070306022535858FRSD0	710003	2535858	4.64	0.11	0.27	FRSD	61	66
102901070306022534967FRSD0	710004	2534967	4.41	0.12	0.26	FRSD	61	66
10290107030602377988WATR0	710005	377988	0.28	0.00	0.02	WATR	122	92
10290107030602377988RIWF0	710006	377988	0.04	0.00	0.00	RIWF	122	77
10290107030603377988WATR0	720001	377988	0.25	0.00	0.01	WATR	122	92
102901070306032535858FRSD0	720002	2535858	4.09	0.10	0.17	FRSD	61	66
102901070306032535873FRSD0	720003	2535873	3.29	0.12	0.14	FRSD	24	66
102901070306032534448FRSD0	720004	2534448	7.82	0.11	0.33	FRSD	61	66
102901070306032534448PAST0	720005	2534448	5.16	0.09	0.22	PAST	61	79
102901070306032534315PAST0	720006	2534315	3.08	0.05	0.13	PAST	61	84
10290107030603377988RIWF0	720007	377988	0.30	0.00	0.01	RIWF	122	77
102901070306042535858PAST0	730001	2535858	2.47	0.09	0.10	PAST	61	79
102901070306042534315PAST0	730002	2534315	4.02	0.05	0.17	PAST	61	84
10290107030604377988WATR0	730003	377988	0.35	0.00	0.01	WATR	122	92
102901070306042535858FRSD0	730004	2535858	5.61	0.10	0.23	FRSD	61	66
102901070306042534315FRSD0	730005	2534315	2.91	0.07	0.12	FRSD	61	66
102901070306042535873FRSD0	730006	2535873	8.64	0.14	0.36	FRSD	24	66
10290107030604377988RIWF0	730007	377988	0.17	0.00	0.01	RIWF	122	77
102901070306052534448FRSD0	740001	2534448	3.87	0.09	0.29	FRSD	61	66
102901070306052535858FRSD0	740002	2535858	5.33	0.11	0.40	FRSD	61	66
102901070306052535873FRSD0	740003	2535873	3.78	0.13	0.28	FRSD	24	66
10290107030605377988WATR0	740004	377988	0.46	0.00	0.03	WATR	122	92
102901070307012536103FRSD0	750001	2536103	3.29	0.09	0.20	FRSD	61	66
102901070307012536110FRSD0	750002	2536110	12.79	0.10	0.79	FRSD	61	66
10290107030701377988RIWF0	750003	377988	0.02	0.00	0.00	RIWF	122	77
102901070307022536110FRSD0	760001	2536110	10.52	0.11	0.79	FRSD	61	66
102901070307022536142FRSD0	760002	2536142	2.82	0.16	0.21	FRSD	24	66
102901070307032536110FRSD0	770001	2536110	13.75	0.10	1.00	FRSD	61	66
102901070307042536110FRSD0	780001	2536110	16.55	0.10	1.00	FRSD	61	66

Table C2. SWAT calibration point source inputs by permitted outfall

NPDES	Outfall	HUC14	Flocnst (m3/day)	Sedcnst (metric tons/day)	Orgncnst (kg/day)	Orgpcnst (kg/day)	No3cnst (kg/day)	Nh3cnst (kg/day)	No2cnst (kg/day)	Minpcnst (kg/day)
MO0132799	001-A	10290107010301	75.8	0.0009	0.000	0.000	0.000	0.000	0.000	0.000
MO0111708	001-A	10290107010302	1,332.5	0.0000	0.000	0.000	0.000	0.000	0.000	0.000
MO0111708	001-B	10290107010302	0.0	0.0041	5.842	1.326	10.556	4.433	1.419	1.022
MO0111708	001-R	10290107010302	0.0	0.0020	0.000	0.000	0.000	0.000	0.000	0.000
MO0132977	001-A	10290107010302	0.0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000
MO0108308	001-A	10290107010403	0.0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000
MO0108308	001-B	10290107010403	0.0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000
MO0113204	001-B	10290107010403	0.0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000
MO0113204	007-A	10290107010403	0.0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000
MO0113204	008-A	10290107010403	0.0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000
MO0113204	009-A	10290107010403	0.0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000
MO0113204	010-A	10290107010404	0.0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000
MO0094854	001-A	10290107020206	2,611.9	0.0124	0.000	0.000	0.000	0.000	0.000	0.000
MO0094854	001-B	10290107020206	0.0	0.0000	13.507	2.353	24.406	10.250	3.281	1.814
MO0130044	001-A	10290107020502	1.4	0.0002	0.000	0.000	0.000	0.000	0.000	0.000
MO0134864	001-A	10290107020502	37.9	0.0002	0.076	0.016	0.162	0.040	0.014	0.023
MO0134864	001-B	10290107020502	75.8	0.0000	0.000	0.000	0.000	0.000	0.000	0.000
MO0134961	001-A	10290107020502	0.0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000

MO0128562	001-A	10290107030203	37.9	0.0249	2.527	0.691	5.404	1.668	0.463	0.997
MO0097594	001-A	10290107030302	0.0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000
MO0022373	001-A	10290107030303	5,259.7	0.0548	5.880	1.913	12.573	3.880	1.078	2.762
MO0022373	SM1-A	10290107030303	0.0	0.0000	5.880	1.913	12.573	3.880	1.078	2.762
MO0022373	SM2-A	10290107030303	0.0	0.0000	5.880	1.913	12.573	3.880	1.078	2.762
MO0116467	001-A	10290107030305	0.0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000
MO0121754	001-A	10290107030305	738.6	0.0007	3.091	0.756	6.585	1.640	0.552	1.090
MO0121924	001-A	10290107030305	37.9	0.0001	2.527	0.691	5.404	1.668	0.463	0.997
MO0133809	001-A	10290107040101	113.6	0.0004	0.000	0.006	0.000	0.000	0.000	0.009
MO0031666	001-A	10290107040204	284.1	0.0043	1.011	0.277	2.163	0.667	0.185	0.399
MO0101636	001-A	10290107040205	0.0	0.0000	0.035	0.009	0.074	0.023	0.006	0.014
MO0101636	001-Q	10290107040205	0.0	0.0000	0.035	0.009	0.074	0.023	0.006	0.014
MO0098990	Unmatched	10290107040307	0.0	0.0000	0.378	0.108	0.804	0.200	0.067	0.157

Table C3. SWAT calibration point source inputs by HUC14 subbasin

Subbasin	FLO	SED	ORGN	ORGP	NO3	NH3	NO2	MINP
10290107010101	0	0	0	0	0	0	0	0
10290107010102	0	0	0	0	0	0	0	0
10290107010103	0	0	0	0	0	0	0	0
10290107010104	0	0	0	0	0	0	0	0
10290107010105	0	0	0	0	0	0	0	0
10290107010201	0	0	0	0	0	0	0	0
10290107010202	0	0	0	0	0	0	0	0
10290107010203	0	0	0	0	0	0	0	0
10290107010204	0	0	0	0	0	0	0	0
10290107010301	75.75758	0.000908	0	0	0	0	0	0
10290107010302	1332.465	0.006169	5.841563	1.325506	10.55557	4.432875	1.418879	1.02202
10290107010303	0	0	0	0	0	0	0	0
10290107010304	0	0	0	0	0	0	0	0
10290107010305	0	0	0	0	0	0	0	0
10290107010401	0	0	0	0	0	0	0	0
10290107010402	0	0	0	0	0	0	0	0
10290107010403	0	0	0	0	0	0	0	0
10290107010404	0	0	0	0	0	0	0	0
10290107010405	0	0	0	0	0	0	0	0
10290107010406	0	0	0	0	0	0	0	0
10290107010407	0	0	0	0	0	0	0	0
10290107020101	0	0	0	0	0	0	0	0
10290107020102	0	0	0	0	0	0	0	0
10290107020103	0	0	0	0	0	0	0	0
10290107020201	0	0	0	0	0	0	0	0
10290107020202	0	0	0	0	0	0	0	0
10290107020203	0	0	0	0	0	0	0	0
10290107020204	0	0	0	0	0	0	0	0
10290107020205	0	0	0	0	0	0	0	0
10290107020206	2611.934	0.012403	13.50663	2.353044	24.40617	10.24951	3.280675	1.814294
10290107020301	0	0	0	0	0	0	0	0
10290107020302	0	0	0	0	0	0	0	0
10290107020303	0	0	0	0	0	0	0	0
10290107020304	0	0	0	0	0	0	0	0
10290107020305	0	0	0	0	0	0	0	0
10290107020401	0	0	0	0	0	0	0	0
10290107020402	0	0	0	0	0	0	0	0
10290107020403	0	0	0	0	0	0	0	0
10290107020404	0	0	0	0	0	0	0	0
10290107020405	0	0	0	0	0	0	0	0
10290107020406	0	0	0	0	0	0	0	0
10290107020407	0	0	0	0	0	0	0	0

Subbasin	FLO	SED	ORGN	ORGP	NO3	NH3	NO2	MINP
10290107020408	0	0	0	0	0	0	0	0
10290107020501	0	0	0	0	0	0	0	0
10290107020502	114.9991	0.00037	0.075814	0.01608	0.161529	0.040222	0.01355	0.0232
10290107020503	0	0	0	0	0	0	0	0
10290107030101	0	0	0	0	0	0	0	0
10290107030102	0	0	0	0	0	0	0	0
10290107030103	0	0	0	0	0	0	0	0
10290107030104	0	0	0	0	0	0	0	0
10290107030201	0	0	0	0	0	0	0	0
10290107030202	0	0	0	0	0	0	0	0
10290107030203	37.85	0.0249	2.527324	0.690899	5.40399	1.66768	0.463153	0.997277
10290107030204	0	0	0	0	0	0	0	0
10290107030301	0	0	0	0	0	0	0	0
10290107030302	0	0	0	0	0	0	0	0
10290107030303	5259.74	0.054768	17.64095	5.73953	37.72034	11.64056	3.232848	8.284714
10290107030304	0	0	0	0	0	0	0	0
10290107030305	776.5152	0.000877	5.618031	1.446441	11.98901	3.307396	1.015523	2.08735
10290107030401	0	0	0	0	0	0	0	0
10290107030402	0	0	0	0	0	0	0	0
10290107030403	0	0	0	0	0	0	0	0
10290107030501	0	0	0	0	0	0	0	0
10290107030502	0	0	0	0	0	0	0	0
10290107030503	0	0	0	0	0	0	0	0
10290107030504	0	0	0	0	0	0	0	0
10290107030505	0	0	0	0	0	0	0	0
10290107030506	0	0	0	0	0	0	0	0
10290107030507	0	0	0	0	0	0	0	0
10290107030601	0	0	0	0	0	0	0	0
10290107030602	0	0	0	0	0	0	0	0
10290107030603	0	0	0	0	0	0	0	0
10290107030604	0	0	0	0	0	0	0	0
10290107030605	0	0	0	0	0	0	0	0
10290107030701	0	0	0	0	0	0	0	0
10290107030702	0	0	0	0	0	0	0	0
10290107030703	0	0	0	0	0	0	0	0
10290107030704	0	0	0	0	0	0	0	0

Table C4. BATHTUB calibration global variables and model options

<u>Global Variables</u>	<u>Mean</u>	<u>CV</u>		<u>Model Options</u>		<u>Code</u>	<u>Description</u>
Averaging Period (yrs)	1	0.0		Conservative Substance		0	NOT COMPUTED
Precipitation (m)	1	0.0		Phosphorus Balance		3	2ND ORDER, FIXED
Evaporation (m)	1.07	0.0		Nitrogen Balance		2	2ND ORDER, DECAY
Storage Increase (m)	-0.07	0.0		Chlorophyll-a		1	P, N, LIGHT, T
				Secchi Depth		1	VS. CHLA & TURBIDITY
<u>Atmos. Loads (kg/km²-yr)</u>	<u>Mean</u>	<u>CV</u>		Dispersion		1	FISCHER-NUMERIC
Conserv. Substance	0	0.00		Phosphorus Calibration		1	DECAY RATES
Total P	53	0.50		Nitrogen Calibration		1	DECAY RATES
Total N	1039.5	0.08		Error Analysis		1	MODEL & DATA
Ortho P	22	0.50		Availability Factors		0	IGNORE

Inorganic N	543	0.12			Mass-Balance Tables		1	USE ESTIMATED CONCS
					Output Destination		2	EXCEL WORKSHEET

Table C5. BATHTUB calibration statistics

Variable =		TOTAL P MG/M3	R² =	0.37							
Global Calibration Factor =			2.00	CV =	0.45						
			Calibration Factor		Predicted		Observed		Log (Obs/Pred)		
Seg	Group	Name	Mean	CV	Mean	CV	Mean	CV	Mean	SE	t
1	1	Near dam	1.00	0.00	45.2	0.22	28.7	0.77	-0.46	0.80	-0.57
2	1	West Arm	1.00	0.00	46.0	0.20	45.9	1.31	0.00	1.32	0.00
3	1	East Arm	0.45	0.00	65.4	0.18	64.5	1.26	-0.01	1.27	-0.01
4	1	Area-Wtd Mean			51.9	0.19	50.2	1.27	-0.03	1.28	-0.03
Variable =		TOTAL N MG/M3	R² =	0.62							
Global Calibration Factor =			0.50	CV =	0.55						
			Calibration Factor		Predicted		Observed		Log (Obs/Pred)		
Seg	Group	Name	Mean	CV	Mean	CV	Mean	CV	Mean	SE	t
1	1	Near dam	1.00	0.00	626.5	0.13	608.5	0.47	-0.03	0.49	-0.06
2	1	West Arm	1.00	0.00	621.9	0.13	638.4	0.42	0.03	0.44	0.06
3	1	East Arm	0.40	0.00	681.5	0.10	735.7	0.53	0.08	0.54	0.14
4	1	Area-Wtd Mean			640.5	0.12	665.8	0.46	0.04	0.48	0.08
Variable =		CHL-A MG/M3	R² =	0.91							
Global Calibration Factor =					1.85	CV =	0.26				
			Calibration Factor		Predicted		Observed		Log (Obs/Pred)		
Seg	Group	Name	Mean	CV	Mean	CV	Mean	CV	Mean	SE	t
1	1	Near dam	0.80	0.00	15.7	0.28	15.4	0.75	-0.02	0.80	-0.02
2	1	West Arm	1.00	0.00	18.1	0.28	20.0	0.59	0.10	0.66	0.15
3	1	East Arm	1.10	0.00	24.4	0.28	24.6	0.62	0.01	0.68	0.01
4	1	Area-Wtd Mean			19.9	0.28	21.0	0.61	0.06	0.67	0.08

Table C6. BATHTUB calibration model segment balances

Component:		TOTAL P		Segment: 1	Near dam		
			Flow	Flow	Load	Load	Conc
Trib	Type	Location	hm³/yr	%Total	kg/yr	%Total	mg/m³
1	1	SWAT output near dam	5.6	0.8%	768.9	1.8%	137
4	4	Outfall	581.0	87.6%	26263.5	60.9%	45
PRECIPITATION			2.5	0.4%	130.4	0.3%	53
INTERNAL LOAD			0.0	0.0%	2327.2	5.4%	
TRIBUTARY INFLOW			5.6	0.8%	768.9	1.8%	137

ADVECTIVE INFLOW			654.9	98.8%	34449.6	79.9%	53
NET DIFFUSIVE INFLOW			0.0	0.0%	5456.3	12.7%	
***TOTAL INFLOW			663.0	100.0%	43132.4	100.0%	65
GAUGED OUTFLOW			581.0	87.6%	26263.5	60.9%	45
ADVECTIVE OUTFLOW			79.5	12.0%	3596.0	8.3%	45
***TOTAL OUTFLOW			660.5	99.6%	29859.5	69.2%	45
***EVAPORATION			2.6	0.4%	0.0	0.0%	
***STORAGE INCREASE			-0.2	0.0%	-7.8	0.0%	45
***RETENTION			0.0	0.0%	13280.7	30.8%	
Hyd. Residence Time =			0.0492	yrs			
Overflow Rate =			268.4	m/yr			
Mean Depth =			13.2	m			
Component: TOTAL N				Segment: 1	Near dam		
			Flow	Flow	Load	Load	Conc
<u>Trib</u>	<u>Type</u>	<u>Location</u>	<u>hm³/yr</u>	<u>%Total</u>	<u>kg/yr</u>	<u>%Total</u>	<u>mg/m³</u>
1	1	SWAT output near dam	5.6	0.8%	4309.3	1.0%	768
4	4	Outfall	581.0	87.6%	364002.5	82.8%	627
PRECIPITATION			2.5	0.4%	2557.2	0.6%	1040
INTERNAL LOAD			0.0	0.0%	1123.1	0.3%	
TRIBUTARY INFLOW			5.6	0.8%	4309.3	1.0%	768
ADVECTIVE INFLOW			654.9	98.8%	420552.0	95.7%	642
NET DIFFUSIVE INFLOW			0.0	0.0%	11070.4	2.5%	
***TOTAL INFLOW			663.0	100.0%	439612.1	100.0%	663
GAUGED OUTFLOW			581.0	87.6%	364002.5	82.8%	627
ADVECTIVE OUTFLOW			79.5	12.0%	49838.9	11.3%	627
***TOTAL OUTFLOW			660.5	99.6%	413841.4	94.1%	627
***EVAPORATION			2.6	0.4%	0.0	0.0%	
***STORAGE INCREASE			-0.2	0.0%	-107.9	0.0%	627
***RETENTION			0.0	0.0%	25878.6	5.9%	
Hyd. Residence Time =			0.0492	yrs			
Overflow Rate =			268.4	m/yr			
Mean Depth =			13.2	m			
Component: TOTAL P				Segment: 2	West Arm		
			Flow	Flow	Load	Load	Conc
<u>Trib</u>	<u>Type</u>	<u>Location</u>	<u>hm³/yr</u>	<u>%Total</u>	<u>kg/yr</u>	<u>%Total</u>	<u>mg/m³</u>
2	1	SWAT output West Arm	432.5	95.8%	73750.7	80.5%	171
PRECIPITATION			19.1	4.2%	1012.3	1.1%	53
INTERNAL LOAD			0.0	0.0%	16882.6	18.4%	

TRIBUTARY INFLOW			432.5	95.8%	73750.7	80.5%	171
***TOTAL INFLOW			451.6	100.0%	91645.6	100.0%	203
ADVECTIVE OUTFLOW			432.5	95.8%	19913.2	21.7%	46
NET DIFFUSIVE OUTFLOW			0.0	0.0%	460.9	0.5%	
***TOTAL OUTFLOW			432.5	95.8%	20374.2	22.2%	47
***EVAPORATION			20.4	4.5%	0.0	0.0%	
***STORAGE INCREASE			-1.3	-0.3%	-61.6	-0.1%	46
***RETENTION			0.0	0.0%	71333.0	77.8%	
Hyd. Residence Time =			0.3902	yrs			
Overflow Rate =			22.6	m/yr			
Mean Depth =			8.8	m			
Component:		TOTAL N		Segment:	2	West Arm	
			Flow	Flow	Load	Load	Conc
<u>Trib</u>	<u>Type</u>	<u>Location</u>	<u>hm³/yr</u>	<u>%Total</u>	<u>kg/yr</u>	<u>%Total</u>	<u>mg/m³</u>
2	1	SWAT output West Arm	432.5	95.8%	363108.9	90.7%	840
PRECIPITATION			19.1	4.2%	19854.5	5.0%	1040
INTERNAL LOAD			0.0	0.0%	14650.2	3.7%	
TRIBUTARY INFLOW			432.5	95.8%	363108.9	90.7%	840
NET DIFFUSIVE INFLOW			0.0	0.0%	2559.8	0.6%	
***TOTAL INFLOW			451.6	100.0%	400173.4	100.0%	886
ADVECTIVE OUTFLOW			432.5	95.8%	268978.8	67.2%	622
***TOTAL OUTFLOW			432.5	95.8%	268978.8	67.2%	622
***EVAPORATION			20.4	4.5%	0.0	0.0%	
***STORAGE INCREASE			-1.3	-0.3%	-831.4	-0.2%	622
***RETENTION			0.0	0.0%	132026.0	33.0%	
Hyd. Residence Time =			0.3902	yrs			
Overflow Rate =			22.6	m/yr			
Mean Depth =			8.8	m			
Component:		TOTAL P		Segment:	3	East Arm	
			Flow	Flow	Load	Load	Conc
<u>Trib</u>	<u>Type</u>	<u>Location</u>	<u>hm³/yr</u>	<u>%Total</u>	<u>kg/yr</u>	<u>%Total</u>	<u>mg/m³</u>
3	1	SWAT output East Arm	222.4	95.9%	33139.1	68.8%	149
PRECIPITATION			9.5	4.1%	503.0	1.0%	53
INTERNAL LOAD			0.0	0.0%	14523.5	30.2%	
TRIBUTARY INFLOW			222.4	95.9%	33139.1	68.8%	149
***TOTAL INFLOW			231.9	100.0%	48165.5	100.0%	208
ADVECTIVE OUTFLOW			222.4	95.9%	14536.4	30.2%	65
NET DIFFUSIVE OUTFLOW			0.0	0.0%	4995.4	10.4%	

***TOTAL OUTFLOW			222.4	95.9%	19531.8	40.6%	88
***EVAPORATION			10.2	4.4%	0.0	0.0%	
***STORAGE INCREASE			-0.7	-0.3%	-43.4	-0.1%	65
***RETENTION			0.0	0.0%	28677.2	59.5%	
Hyd. Residence Time =			0.3364	yrs			
Overflow Rate =			23.4	m/yr			
Mean Depth =			7.9	m			
Component: TOTAL N				Segment: 3	East Arm		
			Flow	Flow	Load	Load	Conc
Trib	Type	Location	hm³/yr	%Total	kg/yr	%Total	mg/m³
3	1	SWAT output East Arm	222.4	95.9%	163104.4	84.6%	733
PRECIPITATION			9.5	4.1%	9864.9	5.1%	1040
INTERNAL LOAD			0.0	0.0%	19896.1	10.3%	
TRIBUTARY INFLOW			222.4	95.9%	163104.4	84.6%	733
***TOTAL INFLOW			231.9	100.0%	192865.3	100.0%	832
ADVECTIVE OUTFLOW			222.4	95.9%	151573.2	78.6%	682
NET DIFFUSIVE OUTFLOW			0.0	0.0%	13630.3	7.1%	
***TOTAL OUTFLOW			222.4	95.9%	165203.5	85.7%	743
***EVAPORATION			10.2	4.4%	0.0	0.0%	
***STORAGE INCREASE			-0.7	-0.3%	-452.7	-0.2%	682
***RETENTION			0.0	0.0%	28114.6	14.6%	
Hyd. Residence Time =			0.3364	yrs			
Overflow Rate =			23.4	m/yr			
Mean Depth =			7.9	m			

Table C7. TMDL BATHTUB model segment balances (2012 critical conditions)

Component: TOTAL P				Segment: 1	Near dam		
			Flow	Flow	Load	Load	Conc
Trib	Type	Location	hm³/yr	%Total	kg/yr	%Total	mg/m³
1	1	SWAT output near dam	3.7	1.0%	56.1	1.3%	15
4	4	Outfall	367.0	99.3%	3571.2	85.3%	10
PRECIPITATION			2.5	0.7%	130.4	3.1%	53
INTERNAL LOAD			0.0	0.0%	134.8	3.2%	
TRIBUTARY INFLOW			3.7	1.0%	56.1	1.3%	15
ADVECTIVE INFLOW			363.4	98.3%	3690.2	88.2%	10
NET DIFFUSIVE INFLOW			0.0	0.0%	174.4	4.2%	
***TOTAL INFLOW			369.6	100.0%	4185.9	100.0%	11
GAUGED OUTFLOW			367.0	99.3%	3571.2	85.3%	10
ADVECTIVE OUTFLOW			0.1	0.0%	1.0	0.0%	10

***TOTAL OUTFLOW			367.1	99.3%	3572.1	85.3%	10
***EVAPORATION			2.6	0.7%	0.0	0.0%	
***STORAGE INCREASE			-0.2	0.0%	-1.7	0.0%	10
***RETENTION			0.0	0.0%	615.4	14.7%	
Hyd. Residence Time =			0.0886	yrs			
Overflow Rate =			149.2	m/yr			
Mean Depth =			13.2	m			
Component: TOTAL N				Segment: 1	Near dam		
			Flow	Flow	Load	Load	Conc
<u>Trib</u>	<u>Type</u>	<u>Location</u>	<u>hm³/yr</u>	<u>%Total</u>	<u>kg/yr</u>	<u>%Total</u>	<u>mg/m³</u>
1	1	SWAT output near dam	3.7	1.0%	1496.0	1.1%	400
4	4	Outfall	367.0	99.3%	130087.3	95.4%	354
PRECIPITATION			2.5	0.7%	2557.2	1.9%	1040
INTERNAL LOAD			0.0	0.0%	359.4	0.3%	
TRIBUTARY INFLOW			3.7	1.0%	1496.0	1.1%	400
ADVECTIVE INFLOW			363.4	98.3%	130267.9	95.5%	359
NET DIFFUSIVE INFLOW			0.0	0.0%	1681.4	1.2%	
***TOTAL INFLOW			369.6	100.0%	136361.9	100.0%	369
GAUGED OUTFLOW			367.0	99.3%	130087.3	95.4%	354
ADVECTIVE OUTFLOW			0.1	0.0%	35.4	0.0%	354
***TOTAL OUTFLOW			367.1	99.3%	130122.7	95.4%	354
***EVAPORATION			2.6	0.7%	0.0	0.0%	
***STORAGE INCREASE			-0.2	0.0%	-61.0	0.0%	354
***RETENTION			0.0	0.0%	6300.2	4.6%	
Hyd. Residence Time =			0.0886	yrs			
Overflow Rate =			149.2	m/yr			
Mean Depth =			13.2	m			
Component: TOTAL P				Segment: 2	West Arm		
			Flow	Flow	Load	Load	Conc
<u>Trib</u>	<u>Type</u>	<u>Location</u>	<u>hm³/yr</u>	<u>%Total</u>	<u>kg/yr</u>	<u>%Total</u>	<u>mg/m³</u>
2	1	SWAT output West Arm	227.8	92.3%	3417.1	62.4%	15
PRECIPITATION			19.1	7.7%	1012.3	18.5%	53
INTERNAL LOAD			0.0	0.0%	1046.4	19.1%	
TRIBUTARY INFLOW			227.8	92.3%	3417.1	62.4%	15
***TOTAL INFLOW			246.9	100.0%	5475.9	100.0%	22
ADVECTIVE OUTFLOW			227.8	92.3%	2233.4	40.8%	10
NET DIFFUSIVE OUTFLOW			0.0	0.0%	21.1	0.4%	
***TOTAL OUTFLOW			227.8	92.3%	2254.5	41.2%	10

***EVAPORATION			20.4	8.3%	0.0	0.0%	
***STORAGE INCREASE			-1.3	-0.5%	-13.1	-0.2%	10
***RETENTION			0.0	0.0%	3234.5	59.1%	
Hyd. Residence Time =			0.7430	yrs			
Overflow Rate =			11.9	m/yr			
Mean Depth =			8.8	m			
Component: TOTAL N				Segment: 2	West Arm		
			Flow	Flow	Load	Load	Conc
<u>Trib</u>	<u>Type</u>	<u>Location</u>	<u>hm³/yr</u>	<u>%Total</u>	<u>kg/yr</u>	<u>%Total</u>	<u>mg/m³</u>
2	1	SWAT output West Arm	227.8	92.3%	91124.0	80.1%	400
PRECIPITATION			19.1	7.7%	19854.5	17.5%	1040
INTERNAL LOAD			0.0	0.0%	2790.5	2.5%	
TRIBUTARY INFLOW			227.8	92.3%	91124.0	80.1%	400
***TOTAL INFLOW			246.9	100.0%	113769.0	100.0%	461
ADVECTIVE OUTFLOW			227.8	92.3%	81032.6	71.2%	356
NET DIFFUSIVE OUTFLOW			0.0	0.0%	359.9	0.3%	
***TOTAL OUTFLOW			227.8	92.3%	81392.6	71.5%	357
***EVAPORATION			20.4	8.3%	0.0	0.0%	
***STORAGE INCREASE			-1.3	-0.5%	-475.6	-0.4%	356
***RETENTION			0.0	0.0%	32852.0	28.9%	
Hyd. Residence Time =			0.7430	yrs			
Overflow Rate =			11.9	m/yr			
Mean Depth =			8.8	m			
Component: TOTAL P				Segment: 3	East Arm		
			Flow	Flow	Load	Load	Conc
<u>Trib</u>	<u>Type</u>	<u>Location</u>	<u>hm³/yr</u>	<u>%Total</u>	<u>kg/yr</u>	<u>%Total</u>	<u>mg/m³</u>
3	1	SWAT output East Arm	135.6	93.5%	1355.5	57.0%	10
PRECIPITATION			9.5	6.5%	503.0	21.1%	53
INTERNAL LOAD			0.0	0.0%	519.9	21.9%	
TRIBUTARY INFLOW			135.6	93.5%	1355.5	57.0%	10
***TOTAL INFLOW			145.0	100.0%	2378.4	100.0%	16
ADVECTIVE OUTFLOW			135.6	93.5%	1456.8	61.3%	11
NET DIFFUSIVE OUTFLOW			0.0	0.0%	153.3	6.4%	
***TOTAL OUTFLOW			135.6	93.5%	1610.1	67.7%	12
***EVAPORATION			10.2	7.0%	0.0	0.0%	
***STORAGE INCREASE			-0.7	-0.5%	-7.1	-0.3%	11
***RETENTION			0.0	0.0%	775.4	32.6%	

Hyd. Residence Time =			0.5530	yrs			
Overflow Rate =			14.2	m/yr			
Mean Depth =			7.9	m			
Component: TOTAL N				Segment: 3	East Arm		
			Flow	Flow	Load	Load	Conc
Trib	Type	Location	hm³/yr	%Total	kg/yr	%Total	mg/m³
3	1	SWAT output East Arm	135.6	93.5%	45138.2	80.0%	333
PRECIPITATION			9.5	6.5%	9864.9	17.5%	1040
INTERNAL LOAD			0.0	0.0%	1386.5	2.5%	
TRIBUTARY INFLOW			135.6	93.5%	45138.2	80.0%	333
***TOTAL INFLOW			145.0	100.0%	56389.5	100.0%	389
ADVECTIVE OUTFLOW			135.6	93.5%	49235.3	87.3%	363
NET DIFFUSIVE OUTFLOW			0.0	0.0%	1321.4	2.3%	
***TOTAL OUTFLOW			135.6	93.5%	50556.7	89.7%	373
***EVAPORATION			10.2	7.0%	0.0	0.0%	
***STORAGE INCREASE			-0.7	-0.5%	-241.3	-0.4%	363
***RETENTION			0.0	0.0%	6074.1	10.8%	
Hyd. Residence Time =			0.5530	yrs			
Overflow Rate =			14.2	m/yr			
Mean Depth =			7.9	m			

Table C8. TMDL BATHTUB model summary balances (2012 critical conditions)

Water Balance Terms (hm³/yr)				Averaging Period = 1.00		Years			
			Inflows		Storage	Outflows----->		Downstr	
Seg	Name	External	Precip	Advect	Increase	Advect	Disch.	Exchange	Evap
1	Near dam	4	2	363	0	0	367	0	3
2	West Arm	228	19	0	-1	228	0	290	20
3	East Arm	136	9	0	-1	136	0	151	10
Net		367	31	0	-2	0	367	0	33
Mass Balance Terms (kg/yr) Based Upon				Predicted	Reservoir & Outflow Concentrations		Component :	TOTAL P	
		Inflows-->			Storage	Outflows----->		Net	Net
Seg	Name	External	Atmos	Advect	Increase	Advect	Disch.	Exchange	Retention
1	Near dam	56	130	3690	-2	1	3571	-174	481
2	West Arm	3417	1012	0	-13	2233	0	21	2188
3	East Arm	1356	503	0	-7	1457	0	153	255
Net		4829	1646	0	-22	1	3571	0	2924

Mass Balance Terms (kg/yr) Based Upon			Predicted	Reservoir & Outflow Concentrations			Component :	TOTAL N	
		Inflows-->			Storage	Outflows- -->		Net	Net
<u>Seg</u>	<u>Name</u>	<u>External</u>	<u>Atmos</u>	<u>Advect</u>	<u>Increase</u>	<u>Advect</u>	<u>Disch.</u>	<u>Exchange</u>	<u>Retention</u>
1	Near dam	1496	2557	130268	-61	35	130087	-1681	5941
2	West Arm	91124	19854	0	-476	81033	0	360	30061
3	East Arm	45138	9865	0	-241	49235	0	1321	4688
Net		137758	32276	0	-778	35	130087	0	40690

Table C9. TMDL BATHTUB model overall balances (2012 critical conditions)

Overall Water & Nutrient Balances										
Overall Water Balance						Averaging Period =	1.00	years		
				Area	Flow	Variance	CV	Runoff		
<u>Trb</u>	<u>Type</u>	<u>Seg</u>	<u>Name</u>	<u>km²</u>	<u>hm³/yr</u>	<u>(hm3/yr)²</u>	<u>=</u>	<u>m/yr</u>		
1	1	1	SWAT output near dam		3.7	0.00E+00	0.00			
2	1	2	SWAT output West Arm		227.8	0.00E+00	0.00			
3	1	3	SWAT output East Arm		135.6	0.00E+00	0.00			
4	4	1	Outfall		367.0	0.00E+00	0.00			
PRECIPITATION				31.1	31.1	0.00E+00	0.00	1.00		
TRIBUTARY INFLOW					367.1	0.00E+00	0.00			
***TOTAL INFLOW				31.1	398.1	0.00E+00	0.00	12.82		
GAUGED OUTFLOW					367.0	0.00E+00	0.00			
ADVECTIVE OUTFLOW				31.1	0.1	0.00E+00	0.00	0.00		
***TOTAL OUTFLOW				31.1	367.1	0.00E+00	0.00	11.82		
***EVAPORATION					33.2	0.00E+00	0.00			
***STORAGE INCREASE					-2.2	0.00E+00	0.00			
Overall Mass Balance Based Upon				Predicted		Outflow & Reservoir Concentrations				
Component:				TOTAL P						
				Load		Load Variance			Conc	Export
<u>Trb</u>	<u>Type</u>	<u>Seg</u>	<u>Name</u>	<u>kg/yr</u>	<u>%Total</u>	<u>(kg/yr)²</u>	<u>%Total</u>	<u>CV</u>	<u>mg/m³</u>	<u>kg/km²/yr</u>
1	1	1	SWAT output near dam	56.1	0.7%	0.00E+00		0.00	15.0	
2	1	2	SWAT output West Arm	3417.1	41.8%	0.00E+00		0.00	15.0	
3	1	3	SWAT output East Arm	1355.5	16.6%	0.00E+00		0.00	10.0	
4	4	1	Outfall	3571.2		4.02E+05		0.18	9.7	
PRECIPITATION				1645.7	20.1%	6.77E+05	100.0 %	0.50	53.0	53.0

INTERNAL LOAD				1701.2	20.8%	0.00E+00		0.00		
TRIBUTARY INFLOW				4828.8	59.1%	0.00E+00		0.00	13.2	
***TOTAL INFLOW				8175.6	100.0 %	6.77E+05	100.0 %	0.10	20.5	263.3
GAUGED OUTFLOW				3571.2	43.7%	4.02E+05		0.18	9.7	
ADVECTIVE OUTFLOW				1.0	0.0%	2.98E-02		0.18	9.7	0.0
***TOTAL OUTFLOW				3572.1	43.7%	4.02E+05		0.18	9.7	115.0
***STORAGE INCREASE				-34.8		0.00E+00		0.00	16.0	
***RETENTION				4638.2	56.7%	6.90E+05		0.18		
	Overflow Rate (m/yr)			11.8		Nutrient Resid. Time (yrs)			0.3397	
	Hydraulic Resid. Time (yrs)			0.7546		Turnover Ratio			2.9	
	Reservoir Conc (mg/m3)			10		Retention Coef.			0.567	
Overall Mass Balance Based Upon				Predicted		Outflow & Reservoir Concentrations				
Component:				TOTAL N						
				Load		Load Variance			Conc	Export
<u>Trb</u>	<u>Type</u>	<u>Seg</u>	<u>Name</u>	<u>kg/yr</u>	<u>% Total</u>	<u>(kg/yr)²</u>	<u>% Total</u>	<u>CV</u>	<u>mg/m³</u>	<u>kg/km²/yr</u>
1	1	1	SWAT output near dam	1496.0	0.9%	0.00E+00		0.00	400.0	
2	1	2	SWAT output West Arm	91124.0	52.2%	0.00E+00		0.00	400.0	
3	1	3	SWAT output East Arm	45138.2	25.9%	0.00E+00		0.00	333.0	
4	4	1	Outfall	130087.3		2.14E+08		0.11	354.5	
PRECIPITATION				32276.5	18.5%	6.67E+06	100.0 %	0.08	1039.5	1039.5
INTERNAL LOAD				4536.4	2.6%	0.00E+00		0.00		
TRIBUTARY INFLOW				137758.2	78.9%	0.00E+00		0.00	375.3	
***TOTAL INFLOW				174571.0	100.0%	6.67E+06	100.0%	0.01	438.5	5622.3
GAUGED OUTFLOW				130087.3	74.5%	2.14E+08		0.11	354.5	
ADVECTIVE OUTFLOW				35.4	0.0%	1.59E+01		0.11	354.5	1.1
***TOTAL OUTFLOW				130122.7	74.5%	2.15E+08		0.11	354.5	4190.7
***STORAGE INCREASE				-871.6		0.00E+00		0.00	401.0	
***RETENTION				45319.9	26.0%	2.13E+08		0.32		
	Overflow Rate (m/yr)			11.8		Nutrient Resid. Time (yrs)			0.5645	
	Hydraulic Resid. Time (yrs)			0.7546		Turnover Ratio			1.8	
	Reservoir Conc (mg/m3)			358		Retention Coef.			0.260	

Appendix D

Weather and Climate Data

Table D1. Monthly Total Precipitation for Pomme de Terre Dam from 1991 -2020

Year	Monthly Precipitation (in)												Annual Total (in)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1991	1.4	0.4	1.3	3.5	4.5	1.4	3.6	1.4	3.8	2.7	4.3	3.1	31.4
1992	0.4	2.3	2.1	2.5	2.1	2.6	7.4	0.4	3.8	1.3	9.4	4.2	M*
1993	M	M	2.0	3.8	6.9	4.1	7.1	2.2	15.2	1.4	5.5	1.8	M
1994	1.0	2.4	1.4	13.2	3.6	2.5	3.1	4.9	5.4	4.7	5.6	1.1	48.9
1995	2.7	0.8	1.8	6.9	10.2	9.2	2.4	2.2	1.0	1.8	1.1	2.7	42.9
1996	M	0.1	2.6	4.2	5.5	2.5	7.1	3.0	6.6	3.7	M	1.1	M
1997	1.6	3.9	3.7	2.4	4.8	3.3	3.4	4.4	2.1	2.6	M	4.5	M
1998	1.7	2.4	6.3	5.4	2.5	5.2	7.5	2.0	4.2	9.1	2.3	1.1	49.5
1999	M	M	M	5.6	7.4	6.1	1.8	4.1	1.6	0.5	1.0	M	M
2000	M	M	M	0.8	3.4	5.3	6.6	0.5	2.6	2.7	M	M	M
2001	M	M	M	2.8	7.1	8.8	9.7	0.9	3.4	7.5	M	M	M
2002	M	M	M	4.4	10.7	2.1	5.5	1.8	2.4	M	M	2.1	M
2003	0.6	M	M	4.3	4.8	2.3	2.3	3.9	6.7	3.3	3.6	3.5	M
2004	2.8	0.5	5.5	3.4	4.0	3.6	5.0	5.2	0.7	5.6	6.9	1.4	44.7
2005	M	M	1.0	M	1.8	6.9	1.3	4.8	M	0.9	M	0.2	M
2006	1.1	T	M	M	M	1.5	3.8	4.2	M	M	M	M	M
2007	2.6	1.5	1.9	4.3	4.5	5.2	1.5	2.7	2.6	2.2	1.2	3.1	33.3
2008	0.7	M	M	9.3	4.3	12.6	2.0	1.8	9.8	2.5	1.5	2.1	M
2009	0.4	0.8	3.3	5.5	6.3	6.8	4.0	5.4	3.2	11.8	M	M	M
2010	2.1	2.5	3.1	4.5	10.0	1.9	8.6	1.6	10.7	0.9	3.7	M	M
2011	1.3	M	M	3.6	7.8	1.7	1.3	6.3	1.8	1.1	5.8	4.0	M
2012	M	M	4.1	6.2	3.2	2.3	1.3	2.4	4.3	M	1.1	1.8	M
2013	2.9	3.8	M	7.1	3.3	4.1	2.1	10.1	2.3	M	2.6	1.5	M
2014	M	M	M	M	2.9	5.2	1.7	2.8	5.6	M	M	1.9	M
2015	0.2	M	M	M	7.2	6.6	8.6	1.4	4.1	M	8.3	10.0	M
2016	0.6	0.5	3.2	4.8	3.8	1.2	9.7	2.8	4.7	1.1	M	0.8	M
2017	2.1	0.1	2.0	10.0	6.4	3.9	2.3	8.1	1.4	5.8	0.6	0.5	43.1
2018	2.5	3.4	2.4	1.8	4.3	3.0	1.8	8.0	1.3	3.7	2.3	4.3	38.9
2019	1.5	2.7	3.8	3.5	13.0	3.4	7.0	5.9	2.1	6.7	2.0	1.2	52.9
2020	4.3	3.0	5.6	6.3	5.6	5.9	5.7	7.0	3.5	4.7	3.1	1.0	55.8
Mean	1.65	1.72	3	5	5.58	4.37	4.5	3.74	4.17	3.67	3.6	2.45	44.1
Max	4.34	3.87	6.29	13.18	12.96	12.58	9.73	10.06	15.18	11.82	9.39	9.98	55.78
	2020	1997	1998	1994	2019	2008	2001	2013	1993	2009	1992	2015	2020
Min	0.23	T**	1.01	0.8	1.84	1.2	1.25	0.44	0.69	0.54	0.62	0.2	31.36
	2015	2006	2005	2000	2005	2016	2005	1992	2004	1999	2017	2005	1991

*M indicates data were missing

**T indicates a trace of precipitation, snowfall, or snow depth

Table D2. Monthly Total Precipitation for Springfield Area, Mo 1991 -2020

Year	Monthly Precipitation (in)												Annual Total (in)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1991	3.0	0.9	1.1	5.2	5.6	0.2	4.2	2.7	3.6	3.8	3.9	3.4	37.6
1992	0.9	2.2	2.2	2.5	2.0	6.0	6.8	3.9	7.4	0.8	9.1	4.3	48.0
1993	2.8	2.7	2.6	3.1	4.4	8.8	4.2	2.7	17.5	1.4	4.1	1.6	55.8
1994	1.4	2.8	3.0	10.6	3.5	3.3	4.5	4.8	1.9	4.7	7.6	1.1	49.0
1995	4.0	1.5	1.2	8.7	7.3	7.8	3.0	2.3	2.4	0.6	0.8	2.5	41.9
1996	3.7	0.6	1.7	5.2	5.1	2.4	2.9	1.9	7.5	5.1	8.1	0.7	44.9
1997	1.4	4.0	4.1	2.8	4.7	3.6	1.7	4.2	3.7	3.4	1.8	3.2	38.5
1998	2.7	4.3	6.5	2.6	3.9	3.2	7.4	3.3	5.8	4.0	3.6	1.4	48.5
1999	4.0	1.9	3.0	7.1	6.5	3.8	1.3	2.0	1.8	1.2	2.0	7.0	41.5
2000	1.2	1.7	2.9	1.1	3.5	8.4	6.8	0.3	2.3	2.5	3.2	1.6	35.4
2001	1.5	5.8	0.9	1.9	5.2	6.6	4.9	5.3	3.2	4.2	2.4	3.5	45.3
2002	3.5	0.8	3.4	4.2	9.5	1.0	3.6	4.3	0.6	3.3	1.0	2.9	37.8
2003	0.4	3.7	2.9	2.6	4.9	4.8	2.0	6.4	3.2	1.5	6.0	4.2	42.6
2004	3.9	0.6	6.4	4.4	2.5	3.4	6.0	1.2	0.1	6.3	7.3	1.2	43.2
2005	6.7	2.4	1.7	3.2	1.5	3.3	1.6	4.1	3.7	4.0	2.5	0.6	35.3
2006	1.8	0.1	2.5	5.5	7.0	1.8	3.6	4.2	2.3	2.2	6.4	1.7	38.9
2007	4.3	2.3	2.7	4.0	4.1	8.1	2.8	4.3	4.9	1.9	1.2	3.7	44.3
2008	3.5	6.4	9.4	4.7	5.2	13.4	2.7	0.6	8.2	2.4	1.1	2.5	60.1
2009	1.3	1.6	3.9	8.3	5.5	4.6	3.7	4.5	5.6	10.0	1.1	1.7	51.9
2010	2.5	1.3	3.4	4.0	7.1	2.3	6.4	1.5	11.7	1.0	4.2	0.7	46.2
2011	0.3	3.4	4.3	7.9	5.9	0.8	1.7	2.9	4.1	1.3	5.3	2.8	40.6
2012	1.0	2.4	2.7	4.4	3.4	1.2	0.3	4.0	5.1	4.3	1.0	1.1	30.9
2013	3.1	2.3	4.8	5.6	8.0	2.3	6.3	5.8	2.2	6.9	2.0	2.6	51.8
2014	1.3	0.5	2.3	2.1	5.3	6.2	2.3	2.0	5.0	7.6	2.3	1.8	38.6
2015	0.8	1.8	3.4	3.2	6.2	4.8	9.2	6.1	4.1	1.5	7.2	11.4	59.7
2016	0.9	0.4	2.9	2.5	4.5	4.4	7.3	2.6	3.9	3.8	2.3	0.6	36.3
2017	4.1	0.4	4.8	12.0	7.4	5.0	1.8	7.1	0.6	2.5	0.4	1.5	47.6
2018	2.0	7.6	3.6	2.3	2.8	4.3	1.0	6.7	4.1	3.6	2.8	4.2	44.9
2019	2.7	3.0	3.4	5.0	13.2	5.0	2.8	5.0	1.6	8.2	3.3	1.3	54.5
2020	5.9	2.9	7.9	4.9	10.9	3.4	2.7	0.9	1.5	4.3	3.0	1.5	49.7
Mean	2.54	2.4	3.51	4.71	5.55	4.47	3.85	3.59	4.31	3.6	3.57	2.61	44.7
Max	6.7	7.57	9.4	12.03	13.16	13.41	9.21	7.11	17.46	9.97	9.11	11.43	60.12
	2005	2018	2008	2017	2019	2008	2015	2017	1993	2009	1992	2015	2008
Min	0.26	0.09	0.85	1.06	1.52	0.23	0.32	0.34	0.1	0.6	0.37	0.61	30.94
	2011	2006	2001	2000	2005	1991	2012	2000	2004	1995	2017	2005	2012